REPORT OF THE PROCEEDINGS

OF THE

Thirty-fifth Annual Convention

OF THE

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION

(*INCORPORATED*)

HELD AT

SARATOGA, N. Y.,

June 23, 24 and 25, 1902.

CHICAGO:
THE HENRY O. SHEPARD COMPANY,
212-214 MONROE STREET.
1902.

OFFICERS FOR 1901-1902.

INCLUDING THE CONVENTION OF 1902.

PRESIDENT:

A. M. WAITT,

New York City.

FIRST VICE-PRESIDENT:

J. N. BARR,

Chicago, Ill.

SECOND VICE-PRESIDENT:

G. W. WEST,

Middletown, N. Y.

THIRD VICE-PRESIDENT:

F. A. DELANO,

Chicago, Ill.

TREASURER:

ANGUS SINCLAIR,

New York City.

SECRETARY:

J. W. TAYLOR,

Chicago, Ill.

OFFICERS FOR 1902-1903.

ELECTED AT CLOSE OF CONVENTION OF 1902.

PRESIDENT:

G. W. WEST,

Middletown, N. Y.

FIRST VICE-PRESIDENT:

W. H. LEWIS,

Roanoke, Va.

SECOND VICE-PRESIDENT:

P. H. PECK,

Chicago, Ill.

THIRD VICE-PRESIDENT:

H. F. BALL,

Cleveland, Ohio.

TREASURER:

ANGUS SINCLAIR,

New York City.

SECRETARY:

J. W. TAYLOR,

Chicago, Ill.

COMMITTEES FOR CONDUCTING THE WORK OF THE ASSOCIATION FOR THE YEAR

1902-1903.

1.—Ton-Mile Statistics.

To determine what is the proper tonnage credit for switching locomotives, and also any other subjects pertinent to the general question.

C. H. QUEREAU, Chairman.
G. R. HENDERSON.
GEORGE L. FOWLER.

2.—Electrically Driven Shops.

To present statistics and information in regard to electrically driven shops.

C. A. SELEY, Chairman.
H. H. VAUGHAN.
T. S. LLOYD.
G. W. DEMAREST.
L. R. POMEROY.

3.—Locomotive Front Ends.

To assist in the tests now being conducted at Purdue University, Lafayette, Indiana, by the *American Engineer and Railroad Journal,* on locomotive front ends.

H. H. VAUGHAN, Chairman.
F. H. CLARK.
A. W. GIBBS.
R. QUAYLE.
W. F. M. GOSS.

4.—Specifications for Locomotive Driving and Truck Axles.

To submit specifications for locomotive driving and truck axles: also to confer with the International Association for Testing Materials.

A. E. MITCHELL, Chairman.
SAMUEL HIGGINS.
W. S. MORRIS.
R. H. SOULE.

5.—Pipe Unions.

To confer with the pipe union manufacturers and submit drawings of proposed standard forms of pipe unions.

C. H. QUEREAU, Chairman.
THOS. FILDES.
E. M. HERR.

6.—Locomotive Forgings.

To work in conjunction with the American Society of Mechanical Engineers, the American Institute of Mining Engineers and the International Association for Testing Material in preparing specifications for locomotive forgings. The committee to be continued until after the 1904 meeting of the International Railway Congress, and report results of its investigations in 1903 and each successive year until its work is completed.

F. H. CLARK.
J. E. SAQUE.
H. H. VAUGHAN.

7.—Present Improvements in Boiler Design.

To present recent improvements that have been made in boiler design, with suggestions as to future improvements.

G. R. HENDERSON.
T. W. DEMAREST.
O. H. REYNOLDS.
JOHN PLAYER.
DAVID VAN ALSTINE.

8.—Piston Valves.

To investigate the subject of piston valves, with special reference to recent improvements.

F. F. GAINES.
R. P. C. SANDERSON.
F. H. CLARK.

9.—Locomotive Performance.

To outline tests and experiments affecting locomotive performance, to be carried on by experts under the direction of committees of the Association.

F. M. WHYTE.
A. W. GIBBS.
E. D. BRONNER.

10.—Revision of Standards and Resolutions.

To revise the standards and resolutions of the Association, and bring them up to date.

R. H. SOULE.
W. McINTOSH.
A. M. WAITT.

11.—The Progress of the Year.

To embrace improvements in locomotives, shop practices, new machines, tools, etc., and to submit new principle and methods for discussion.

A. M. WAITT.
E. M. HERR.
S. F. PRINCE, JR.

12.—Cost of Running High-Speed Trains.

W. W. ATTERBURY.
A. M. WAITT.
H. D. TAYLOR.

13.—Subjects.

G. M. BASFORD.
R. D. SMITH.
A. L. HUMPHREY.

CONSTITUTION AND BY-LAWS.

ARTICLE I.

NAME.

The name of this Association shall be the "American Railway Master Mechanics' Association."

ARTICLE II.

OBJECTS OF ASSOCIATION.

The objects of this Association shall be the advancement of knowledge concerning the principles, construction, repair and service of the rolling stock of railroads, by discussions in common, the exchange of information, and investigations and reports of the experience of its members; and to provide an organization through which the members may agree upon such joint action as may be required to give the greatest efficiency to the equipment of railroads which is intrusted to their care.

ARTICLE III.

MEMBERSHIP.

SECTION 1. The following persons may become active members of the Association on being recommended by two members in good standing, signing an application for membership and agreement to conform to the requirements of the Constitution and By-Laws, or authorizing the Secretary to sign the Constitution for them;

(1) Those above the rank of general foreman, having charge of the design, construction or repair of railway rolling stock.

(2) General foremen, if their names are presented by their superior officers.

(3) Two representatives from each locomotive and car-building works.

SEC. 2. Civil and mechanical engineers, or other persons having such a knowledge of science or practical experience in matters pertaining to the construction of rolling stock as would be of special value to the Association or railroad companies, may become associate members on being recommended by three active members. The name of such candidate shall then be referred to a committee, to be appointed by the President, which shall investigate the fitness of the candidate, and report to the Executive Committee of the Association at the next annual meeting. If the report be unanimous in favor of the candidate the name shall be submitted to letter ballot, and five dissenting votes shall reject. The number of associate members shall not exceed twenty, and they shall be entitled to all the privileges of active members, excepting that of voting.

SEC. 3. All members of the Association, excepting as hereafter provided, shall be subject to the payment of such annual dues as it may be necessary

to assess for the purpose of defraying the expenses of the Association, provided that no assessment shall exceed $5 a year.

Such dues shall be payable when the amount thereof is announced by the President, at each annual meeting. Any member who shall be two years in arrears for annual dues, shall be notified of the fact, and if the arrears are not paid within three months after such notification, his name shall be taken from the roll and he be duly notified of the same by the Secretary.

SEC. 4. Any person who has been or may be duly qualified as a member of this Association will remain such until his resignation is voluntarily tendered, or he becomes disqualified by the terms of the Constitution. Members whose names have been dropped for non-payment of dues may be restored to membership by the unanimous consent of the Executive Committee on the payment of all back dues.

SEC. 5. Members of the Association, active or associate, who have been in good standing for not less than five years, and who through age or other cause cease to be actively engaged in the mechanical department of railway service, may, upon the unanimous vote of the members present at the annual meeting, be elected honorary members. The nominations must be made by the Executive Committee. The dues of the honorary members shall be remitted, and they shall have all the privileges of active members except that of voting.

SEC. 6. Any member who, during the meetings of the Association, shall be guilty of dishonorable conduct which is disgraceful to a railroad officer and a member of the Association, or shall refuse to obey the chairman when called to order, may be expelled by a two-thirds affirmative vote at any regular meeting of the Association held within one year from the date of the offense.

ARTICLE IV.

OFFICERS.

SECTION 1. The officers of the Association shall be a President, a First Vice-President, a Second Vice-President, a Third Vice-President, a Treasurer, and a Secretary; and they, with the exception of the Secretary, shall constitute the Executive Committee of the Association.

ARTICLE V.

DUTIES OF OFFICERS.

SECTION 1. It shall be the duty of the President to preside at all the meetings of the Association, appoint all committees—designating the chairman — except as hereinafter provided, and approve all bills against the Association for payment by the Treasurer.

SEC. 2. It shall be the duty of the Vice-Presidents, according to rank, to perform the duties of the President in his absence from the meetings of the Association.

SEC. 3. In case of the absence of both President and Vice-Presidents, the members present shall elect a President *pro tempore*.

SEC. 4. It shall be the duty of the Secretary to keep a full and correct

record of all transactions at the meetings of the Association; to keep a record of the names and places of residence of all members, and the name of the railway they each represent; to certify to the persons who are eligible as candidates for the Association's scholarships at the Stevens Institute of Technology; to receive and keep an account of all money paid to the Association and deliver the same to the Treasurer, taking his receipt for the amount; to receive from the Treasurer all paid bills, giving him a receipted statement of the same.

SEC. 5. It shall be the duty of the Treasurer to receive all money from the Secretary belonging to the Association; to receive all bills and pay the same, after having approval of the President; to deliver all bills paid to the Secretary at the close of each meeting, taking a receipted statement of the same and to keep an accurate book account of all transactions pertaining to his office.

ARTICLE VI.

EXECUTIVE COMMITTEE.

SECTION 1. The Executive Committee shall exercise a general supervision over the interests and affairs of the Association, recommend the amount of the annual assessment, to call, to prepare for, and to conduct general conventions, and to make all necessary purchases, expenditures and contracts required to conduct the current business of the Association, but shall have no power to make the Association liable for any debt to an amount beyond that which at the time of contracting the same shall be in the Treasurer's hands in cash, but not subject to prior liabilities. All expenditures for special purposes shall only be made by appropriations acted upon by the Association at a regular meeting.

SEC. 2. The Executive Committee shall receive, examine and approve before public reading, all communications, papers and reports on all mechanical and scientific matters; they shall decide what portion of the reports, papers and drawings shall be submitted to each convention and what portion shall be printed in the annual report.

SEC. 3. Three members shall constitute a quorum for the transaction of business.

SEC. 4. The Executive Committee shall form with a committee of the Master Car Builders' Association a Joint Committee to decide on the place of meeting for the annual convention.

ARTICLE VII.

ASSOCIATION SCHOLARSHIPS.

It shall be the duty of the Secretary to issue a circular annually intimating the date and place when and where candidates may be examined for the scholarships of the Association in the Stevens Institute of Technology, Hoboken, New Jersey.

Acceptable candidates for the scholarship shall be, first, sons of mem-

bers or of deceased members of the Association. If there is not a sufficient number of such applicants for the June examination, then applications will be received from other railroad employes or the sons of other railroad employes for the Fall examination. The Secretary shall issue a proper circular in this case as before. In extending the privilege outside of the families of members, preference shall be given to employes or the sons of employes, or the sons of deceased employes of the mechanical departments.

Candidates for these scholarships shall apply to the Secretary of this Association, and if found eligible shall be given a certificate to that effect for presentation to the school authorities. This will entitle the candidate to attend the preliminary examination. If more than one candidate passes the preliminary examination, the applicant passing the highest examination shall be entitled to the scholarship, the school authorities settling the question.

The successful candidate shall be required to take the course of mechanical engineering.

ARTICLE VIII.

ELECTION OF OFFICERS.

SECTION 1. The officers of the Association, except the Secretary as hereinafter provided, shall be elected by ballot separately without nomination at the regular meeting of the Association, held in June of each year. A majority of all votes cast shall be necessary to an election, and elections shall not be postponed.

SEC. 2. Two tellers shall be appointed by the President to conduct the election and report the result.

SEC. 3. A Secretary from among the members of the Association shall be appointed by a majority of the Executive Committee at its first meeting after the annual election, or as soon thereafter as the votes of a majority of the members of the Executive Committee can be secured for a candidate. The term of office of the Secretary thus appointed, unless terminated sooner, shall cease at the first meeting, after the next annual election succeeding his appointment, of the Executive Committee organized for the transaction of business. Two-thirds of the members of the Executive Committee shall have power to remove the Secretary at any time. His compensation, if any, shall be fixed for the time that he holds office by vote of the majority of the Executive Committee. He shall also act as Secretary of the Executive Committee.

ARTICLE IX.

AUDITING COMMITTEE.

SECTION 1. At the first session of the annual meeting an Auditing Committee, consisting of three members not officers of the Association, to be nominated by any member who does not hold office, shall be elected in the same way as officers are voted for. This Auditing Committee shall examine the accounts and vouchers of the Treasurer and certify whether they have been found correct or not. After the performance of this duty they shall be discharged by the acceptance of their report by the Association.

COMMITTEE ON SUBJECTS FOR INVESTIGATION AND DISCUSSION.

SEC. 2. At each annual meeting the President shall appoint a committee whose duty it shall be to report at the next annual meeting subjects for investigation and discussion, and if the subjects are approved by the Association the President, as hereinafter provided, shall appoint committees to report on them. It shall also be the duty of the committee to receive from members questions for discussion during the time set apart for that purpose. This committee shall determine whether such questions are suitable ones for discussion, and if so, they shall so report them to the Association.

COMMITTEES ON INVESTIGATION.

SEC. 3. When the Committee on Subjects has reported, and the Association approved of subjects for investigation, the President shall appoint individuals or special committees to investigate and report on them, and may authorize and appoint a *special* committee to investigate and report on any subject which a majority of the members present may approve; or individual papers may be presented to the Association after approval by the Executive Committee. Papers and reports shall be presented by abstracts, which shall not occupy more than ten minutes in the reading unless otherwise ordered by the Association.

ARTICLE X.

AMENDMENTS.

SECTION I. The Constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that written notice of the proposed amendments has been given at a previous meeting at least six months before.

BY-LAWS.

TIME OF MEETING.

I. The regular meeting of the Association shall be held annually in June of each year.

HOURS OF SESSION.

II. The regular hours of session shall be from 9.30 o'clock A.M. to 1.30 o'clock P.M.

PLACE OF MEETING.

III. The time and place for holding the Annual Convention shall be selected by a Joint Committee composed of the President, three Vice-Presidents and Treasurer of this Association and a corresponding com-

mittee from the Master Car Builders' Association. This Joint Committee shall meet within six months after the convention and decide upon the time and place of meeting.

QUORUM.

IV. At any regular meeting of the Association, fifteen or more members entitled to vote shall constitute a quorum.

ORDER OF BUSINESS.

V. The business of the meetings of this Association shall, unless otherwise ordered by a vote, proceed in the following order:

1. Opening prayer.
2. Address by the President.
3. Acting on the minutes of the last meeting.
4. Reports of Secretary and Treasurer.
5. Assessment and announcement of annual dues.
6. Election of Auditing Committee.
7. Unfinished business.
8. New business.
9. Reports of committees.
10. Reading of papers and discussion of questions propounded by members.
11. Routine and miscellaneous business.
12. Election of officers.
13. Adjournment.

QUESTIONS FOR DISCUSSION, SPECIAL ORDER OF.

VI. Unless otherwise ordered, the discussion of questions proposed by members shall be the special order from 12 o'clock M. to 1 P.M. of each day of the annual meeting.

DECISIONS.

VII. The votes of a majority of the members shall be required to decide any question, motion or resolution which shall come before the Association, unless otherwise provided.

DISCUSSIONS.

VIII. No patentees or their agents shall be admitted in the meetings of the Association for the purpose of advocating the claims of any patent or patentee, unless by unanimous consent.

IX. No member shall speak more than twice in the discussion of any question until all the other members who want to speak and have not been heard, have spoken, and no member shall have the floor more than five minutes at a time unless otherwise ordered.

NAMES AND ADDRESSES OF MEMBERS.

ACTIVE MEMBERS.

JOINED.	NAME.	ROAD.	ADDRESS.
1896	Adams, T. E	St. Louis & Southwestern	Pine Bluff, Ark.
1888	Addis, J. W	Texas & Pacific	Marshall, Tex.
1895	Aiken, C. L	Boston & Maine	Springfield, Mass.
1887	Aldcorn, Thos		95 Liberty st., New York City
1902	Aldana, H. Lopez	Central Northern	Lucuman, Arg. Rep., S. A
1892	Allen, G. S	Philadelphia & Reading	Tamaqua, Pa.
1894	Allin, Richard	Arkansas Midland	Helena, Ark.
1895	Amann, W. E		1536 St. Charles st., Alameda, Cal
1892	Antz, Oscar	Lake Shore & Michigan Southern,	Elkhart, Ind.
1900	Appleyard, W. P	N. Y. N. H. & H	New Haven, Conn.
1887	Arp, W. C	Terre Haute & Indianapolis	Terre Haute, Ind.
1901	Ashworth, Jas	Louisville & Nashville	Birmingham, Ala.
1890	Atkinson, R	Philadelphia & Reading	Reading, Pa.
1896	Atterbury, W. W	Pennsylvania	Altoona, Pa.
1887	Augustus, W	Keokuk & Western	Centerville, Iowa.
1886	Austin, W. L		Baldwin Loco. Works, Philadelphia, Pa.
1896	Babcock, C. M	Texas & Pacific	Gouldsboro, New Orleans, La.
1898	Baker, C. F	Boston Elevated	Boston, Mass.
1902	Baker, P. G	Panama......24 State st., New York.	Colon. (Aspinwall).
1894	Balkam, S. T		Calle Teatro, No. 17, Monterey, N. L., Mexico.
1901	Ball, H. F	L. S. & M. S	Cleveland, Ohio.
1898	Barhydt, J. A	Buff. Roch. & Pitts	Rochester, N. Y.
1894	Barnes, Chas. H		52 Pearl st., Springfield, Mass.
1888	Barnes, J. B	Wabash	Springfield, Ill.
1877	Barnett, J. Davis		Stratford, Ont.
1890	Barnum, M. K	Union Pacific	Omaha, Neb.
1890	Barr, J. N	Chi., Mil. & St. Paul	335 Old Colony Bld., Chicago.
1899	Barrington, Edw		P. O. Box 21, Cordoka, Mex.
1895	Bartlett, Henry	Boston & Maine	Boston, Mass.
1899	Bates, F. L		1921 H st., Sacramento, Cal.
1895	Bay, J. P		
1889	Bean, S. L	Northern Pacific	Brainerd, Minn.
1892	Beattie, A. L	New Zealand Gov't	Wellington, N. Z.
1899	Beauclerk, T	Central Argentino	Rosario de Santa Fe, Arg. Rep., S. A.
1894	Beaumont, J. G	Southern R'ys of Peru	Arequipa, Peru.
1892	Bechhold, H. G		Cleveland Frog & Crossing Co., Cleveland, Ohio.
1885	Beckert, Andrew	Louisville & Nashville	New Decatur, Ala.
1896	Belcher, A. W	Ulster & Delaware	Rondout, N. Y.
1892	Beltz, A. J	Del. Sus. & Schuylkill	Drifton, Pa.
1900	Bentley, H. T	Chicago & North-Western	Clinton, Iowa.
1902	Berry, Arthur O		Boston, Mass.
1891	Berry, J. H		
1900	Best, W. N		311 Henne Block, Los Angeles, Cal.

JOINED.	NAME.	ROAD.	ADDRESS.
1892	Billingham, Jos	Baltimore & Ohio	Cumberland, Md.
1902	Bingaman, Chas. A	Lima Loco. & Mch. Co.	Lima, Ohio.
1901	Birse, John	Chicago Great Western	St. Paul, Minn.
1899	Bissett, J. R	Atlantic Coast Line	Savannah, Ga.
1872	Blackall, R. C	Delaware & Hudson	Albany, N. Y.
1901	Blake, R. P	Northern Pacific	St. Paul, Minn.
1900	Boardman, S. R	Gila Valley, Globe & Northern	Globe, Ariz.
1898	Bocquet, H. C	Leopoldina R'y	Rio de Janeiro, Brazil, S. A.
1899	Boldridge, R. M	Lehigh Valley	Sayre, Pa.
1899	Bonner, J		
1897	Bowles, C. K	Farmville & Powhatan	Chester, Va.
1895	Bradeen, A. A	L. S. & M. S	Cleveland, Ohio.
1895	Bradeen, J. O	N. Y. Cent. & Hudson River	E. Buffalo, N. Y.
1886	Bradley, W. F	Ann Arbor	Durand, Mich.
1894	Branch, Geo. E	N. Y. Dock Co. Ter. R'y,	foot Montague st., Brooklyn, N. Y.
1896	Brangs, P. H		11 Broadway, New York City.
1893	Brantner, Z. T	Baltimore & Ohio	Brunswick, Md.
1900	Brassell, J. K	Cal. Northwestern	Tiburon, Cal.
1902	Brazier, F. W	N. Y. Cent. & Hudson River	New York City.
1892	Brehm, W. H	Mo. Kan. & Texas	Parsons, Kan.
1897	Briggs, D. D	Louisville & Nashville	Montgomery, Ala.
1879	Briggs, R. H	K. C. M. & B	Memphis, Tenn.
1896	Bronner, E. D	Michigan Central	Detroit, Mich.
1887	Brooke, Geo. D	Iowa Central	Marshalltown, Iowa.
1892	Brown, David	Del. Lack. & Western	Scranton, Pa.
1896	Brown, M. D	Mo. Kan. & Texas	New Franklin, Mo.
1891	Brown, W. A	Central New England	Hartford, Conn.
1895	Browne, T. R	Westinghouse Air Brake Co.	Lock Box 35, Wilmerding, Pa.
1882	Brownell, F. G		Muncie st., Muncie, Ind.
1897	Bruce, Geo. A	Great Northern	Willmar, Minn.
1890	Bruck, Henry T	Cumb. & Penna	Mt. Savage, Md.
1882	Bryan, H. S	Duluth & Iron Range	Two Harbors, Minn.
1900	Bryan, L. H	Duluth & Iron Range	Two Harbors, Minn.
1900	Buchanan, A., Jr	Delaware & Hudson	Green Island, N. Y.
1902	Buchanan, Jas	Amer. Loco. Co	Richmond, Va.
1887	Buchanan, Wm		
1893	Bush, S. P	Buckeye Malleable Iron Co.	Columbus, Ohio.
1870	Bushnell, R. W	B. C. R. & N	Cedar Rapids, Iowa.
1893	Butcher, Geo. W	San Antonio & A. Pass	San Antonio, Tex.
1891	Butler, L. M	N. Y. New Haven & Hartford	Auburn, R. I.
1896	Callander, R. T		Caixado Carreio, 433 Para, Brazil, S. A.
1891	Campbell, John D		596 East 141st st., New York City.
1900	Canfield, L. T	Del. Lack. & Western	Scranton, Pa.
1896	Cannon, T. E	Great Northern	Barnesville, Minn.
1902	Caracristi, V. Z	Intercolonial	Moncton, N. B., Can.
1900	Carney, J. A	Chicago, Burlington & Quincy	West Burlington, Iowa.
1896	Carr, Jas	St. L. I. M. & S	Van Buren, Ark.
1889	Casanave, F. D	Baltimore & Ohio	Baltimore, Md.
1890	Casey, J. J	Haskel & Barker	Michigan City, Ind.
1892	Chamberlin, E	Brooklyn Rapid Transit	Brooklyn, N. Y.
1893	Chambers, Jno S	Atlantic Coast Line	Wilmington, N. C.
1875	Chapman, F. L	Southern R'y	Washington, D. C.
1901	Chase, C. F	Amer. Loco. Co	Manchester, N. H
1896	Chase, F. A	Hannibal & St. Joseph	St. Joseph, Mo.
1893	Childs, H. A	Erie	Jersey City, N. J.
1896	Christopher, J	Toronto, Hamilton & Buffalo	Hamilton, Ontario, Can.

JOINED.	NAME.	ROAD.	ADDRESS.
1899	Christie, W. K	Pere Marquette	Saginaw, Mich.
1896	Chubb, Thos. L	Buenos Ayres W.	La Plata, Arg Rep., S. A.
1899	Clark, F. H	Chicago, Burlington & Quincy	Chicago. Ill.
1886	Clark, Isaac W		Fayetteville, N. C.
1897	Clarke, Owen		Marshall, Texas.
1901	Clay, S. B		120 Chestnut st., Little Rock, Ark.
1893	Cleaver, F C		90 Sheboygan st., Fond du Lac, Wis.
1892	Clifford, C. J		372 First ave. Elizabeth, N. J.
1887	Clifford, J. G		Tenth and Kentucky sts., Louisville, Ky.
1887	Cloud, John W		82 York Road, King's Cross, London, Eng.
1896	Cole, F. J	Amer. Loco. Co	Schenectady, N. Y.
1891	Collinson, Jas		1018 Topeka ave., Topeka, Kan.
1901	Conlon, T. M	Southern	Charleston, S. C.
1901	Connatty, J. W	C. I. & W	Indianapolis, Ind.
1890	Conolly, J. J	Dul. So. Shore & Atlantic	Marquette, Mich.
1879	Cook, John S	Georgia	Augusta, Ga.
1898	Cooper, C. J	Toledo & Ohio Central	Kenton, Ohio.
1901	Cooper, Chas. T	Toledo & Ohio Central	Kenton, Ohio.
1898	Cooper, D. S	Rich. Fred. & Potomac	Richmond, Va.
1876	Cory, C. H	Cin., Hamilton & Dayton	Lima, Ohio.
1902	Cota. A. J	Chicago. Burlington & Quincy	Chicago.
1900	Courtney, D. C		1130 Sheffield st., Allegheny, Pa.
1900	Crawford, D. F	Pennsylvania Lines	Ft. Wayne, Ind.
1892	Crawford, S. B	Baltimore & Ohio	Parkersburg, W. Va.
1885	Cromwell, A. J		1411 Hollins st., Baltimore, Md.
1902	Cross, C. W	Lake Shore & Mich. So	Elkhart, Ind.
1902	Cross, J. W	Great Western Ry	Swindon, England.
1893	Cross, W	Canadian Pacific	Montreal, Can.
1896	Cullinan, J	Col. Sand. & Hocking	Columbus, Ohio.
1899	Cumback, R. O		Box 789, Beaumont, Tex.
1899	Cunningham, Jas	Choc., Okla. & Gulf	Shawnee, O. T.
1900	Curley, M. S	Gulf & Ship Island	Gulfport, Miss.
1872	Cushing, G. W		Evanston, Ill.
1888	Dallas, Wilber C	Missouri Pacific	St. Louis, Mo.
1890	Davies, J. M		56 Broad st., Plattsburgh, N. Y.
1899	Davis, Chas. H		25 Broad st., New York City.
1892	Davis, Ed E	N. Y. Cent. & Hudson River	West Albany, N. Y.
1899	Davis, M. R	Portland & Rumford Falls	Rumford Falls, Me.
1893	Davis, Wm. J	Pitts & Western	Foxbury, Pa.
1900	Davisson, F. E	San Pedro. Los Angeles & Salt Lake	Los Angeles, Cal.
1897	Dawson, E		
1896	Deeble, Wm. R		Launceston, Tasmania.
1891	Deems, J. F	Amer. Loco. Co	Schenectady, N. Y.
1896	De Gress, C		Mex. Nat. Construc. Co., Colima, Mex.
1897	De Haven, C. A		
1897	Delaney, C. A	Amer. Loco. Co	Scranton, Pa.
1895	Delaney, H		14 Stuyvesant Place, Staten Island, N. Y.
1899	Delano, F. A	C. B. & Q	Chicago.
1900	Demarest, T. W	Pennsylvania Lines	Columbus, Ohio.
1896	Dickerson, S. K	Lake Shore & Michigan South'n	Collinwood, Ohio.
1887	Dickson, G. L	Amer. Loco. Co	Scranton, Pa.
1902	Dickson, Geo	Great Northern	St. Paul, Minn.
1900	Dillon, S. J	Pennsylvania	Jersey City, N. J.
1894	Dixon, W. F		Singer Mfg. Co., Podolsk, Moscow, Govt., Russia.
1897	Doebler, C. H	Wabash	Springfield, Ill.
1898	Dolan, S. M	Wiggins Ferry Co	East St. Louis, Ill.

	JOINED.	NAME.	ROAD.	ADDRESS.
	1896	Donohue, Geo	Erie	Meadville, Pa.
	1893	Dow, Jas. M		Kenton, Ohio.
	1890	Downing, T		Station 5, Minneapolis, Minn.
	1899	Downing, T. M	Kanawha & Michigan	Charleston, W. Va.
	1893	Drury, Michael J	Atchison, Topeka & Santa Fe	Arkansas City, Kan.
	1900	Dunn, A. J	Atl. Knoxville & Northern	Blue Ridge, Ga.
	1896	Dunn, J. F	Oregon Short Line	Salt Lake City, Utah.
	1900	Edwards, J. A	Rio Grande Southern	Ridgway, Colo.
	1899	Egan, J. A	Mexican Southern	Oaxaca, Mex.
	1900	Elden, Edw	N. Y. C. & H. R	W. Albany, N. Y.
	1869	Elliott, Henry		East St. Louis, Ill.
	1899	Ellis, H. D	Anglo-Chilian Nitrate & R'y Co.	Tocapilla, Chili.
	1895	Ellis, John	Maine Central	Waterville, Me.
	1893	Ellis, John J	C. St. P. M. & O	St Paul, Minn.
	1901	Emerson, G. H	Great Northern	Spokane, Wash.
	1893	English, H. W		Birmingham, Ala.
	1893	English, Richard		326 Fifth st., San Bernardino, Cal.
	1881	Ennis, W. C	Delaware & Hudson Co	Carbondale, Pa.
	1898	Erskine, A. S		Houghton, Mich.
	1892	Esson, R. C		1104 Broadway, Oakland, Cal.
	1898	Ettinger, R. L	C. C. C. & St. L	Indianapolis, Ind.
	1900	Ewing, J. J	Chesapeake & Ohio	Richmond, Va.
	1900	Feeley, T. M	Southern	Birmingham, Ala.
	1885	Ferguson, G. A	N. Y. C. & H. R	Depew, N. Y.
	1901	Fildes, Thos	Long Island	Richmond Hill, L. I., N. Y.
	1896	Fisher, G. P		
	1892	Fitzmorris, Jas	Chicago Junction	Union Stock Yards, Chicago, Ill.
	1901	Fogg, J. W	Chicago Ter. Transfer	E. Chicago, Ind.
	1895	Foller, P. P	Pennsylvania	Oil City, Pa.
	1896	Foque, T. A	M. St. Paul & S. Ste M	Minneapolis, Minn.
	1901	Forbes, S. F		Jersey City, N. J.
	1900	Forsyth, A	Chicago, Burlington & Quincy	Aurora, Ill.
	1888	Forsyth, Wm		Northumberland, Pa.
	1890	Foulk, John	Jacksonville & St. Louis	Litchfield, Ill.
	1877	Fowle, J. W		Riverside, California.
	1891	French, R. E	Southern Pacific	Kern, Kern Co., Cal.
	1898	Frey, N	Chicago, Bur. & Quincy	La Crosse, Wis.
	1890	Fuller, C. F	Erie	Susquehanna, Pa.
	1872	Fuller, Wm		213 Kennard st., Cleveland, Ohio.
	1893	Gage, George W		Box 345 Epping, N. H.
	[illegible]	Gaines, F. F	Lehigh Valley	South Bethlehem, Pa.
	1898	Galbraith, H. D		Texarkana, Ark.
	[illegible]	Galbraith, R. M		Pine Bluff, Ark.
	[illegible]	Gallagher, G. A	Great Northern	W. Superior, Wis.
	[illegible]	Gardner, A	C. & C. V	Cooperstown, N. Y.
	[illegible]	Garrick, J. R	Gulf, Houston & San Antonio	El Paso, Tex.
	[illegible]	Garstang, Wm	C. C. C. & St. L	Indianapolis, Ind.
	[illegible]	Gaskins, W. B	Pecos Valley & Northeastern	Roswell, N. M.
	[illegible]	Gentry, T. W		American Loco. Co., Richmond, Va.
	[illegible]	Gibb, T. M	Crystal River	Redstone, Colo.
	1888	Gibbs, A. W	P. W. & B	Philadelphia, Pa.
	[illegible]	Gibbs, George	Rapid Transit Subway Const. Co	18-21 Park Row Bldg., N. Y.
	[illegible]	Gibson, J. A	Cleveland, Cin., Chic. & St. Louis	Urbana, Ill.
	[illegible]	Gill, Jno	C. I. & L.	Lafayette, Ind.

JOINED.	NAME.	ROAD	ADDRESS.
1891	Gillis, H. A		American Loco. Co., Richmond, Va.
1883	Gilmore, W. L	N. Y. C. & St. L	Cleveland, Ohio.
1893	Gilmour, George		N. Y. Telephone Co., 15 Dey st., New York.
1890	Givin, F. A		Box 595 Wilmerding, Pa.
1897	Glaser, J	Cleveland & Marietta	Cambridge, Ohio.
1891	Glass, John C	Pennsylvania	Verona, Pa.
1880	Gordon, H. D		71 John st., New York.
1900	Gould, J. E	C. N. O. & T. P	Chattanooga, Tenn.
1899	Gould, R	Buenos Ayres Great Southern	Buenos Ayres, Arg. Rep., S. A.
1892	Graham, Charles		401 Madison ave., Scranton, Pa.
1894	Graham, J. A		27 Park ave., Detroit, Mich.
1894	Grant, A. S	St. Louis, Iron Mount'n & South'n	Argenta, Ark.
1889	Greatsinger, J. L	Brooklyn Rapid Transit	Brooklyn, N. Y.
1897	Greaven, Luis	Interoceanic	Puebla, Mex.
1895	Green, Wilbur	San Antonio & Aransas Pass	Yoakum, Tex.
1896	Greenwood, Alfred W	East Broad Top	Rockhill Furnace, Pa.
1885	Griffith, Fred B		1049 Elmwood ave., Buffalo, N. Y.
1893	Gross, R. J		American Loco. Co., 25 Broad st., New York.
1896	Groves, J. R	Colorado Midland	Colorado City, Colo.
1900	Gurry, Geo		International Power Co., Providence, R. I.
1875	Haggett, J. C		Dunkirk, N. Y.
1893	Hainen, J	Erie	Hornellsville, N. Y.
1898	Hair, John	Balto. & Ohio S.-W	Washington, Ind.
1896	Hall, J. W		
1902	Hammett, P. M	Maine Central	Portland, Me.
1891	Hancock, Geo. A	St. Louis & San Francisco	Springfield, Mo.
1893	Hancock, Wm. S		3148 Olive st., St. Louis, Mo.
1896	Hanglin, J. A	Hot Springs	Malvern, Ark.
1899	Hansgen, J. A	International & Gt. Northern	Palestine, Tex.
1893	Hardie, Jas		Hardie & Co., Valparaiso, Chili.
1900	Harrington, W	Boston & Maine	Mechanicsville, N. Y.
1902	Harris, J. D	Baltimore & Ohio	Baltimore, Md.
1896	Harrison, Jno	San Paulo	San Paulo, Brazil, S. A.
1898	Harrison, F. J	Buffalo, Rochester & Pittsburg	Du Bois, Pa.
1901	Haselton, G. H	N. Y. C. & H. R	W. Albany, N. Y.
1889	Haskell, B	Pere Marquette	Saginaw, Mich.
1888	Hassman, Wm	Shelton Bros. & Hassman	Paducah, Ky.
1875	Hatswell, T. J	Pere Marquette	Saginaw, E. S., Mich.
1897	Hatswell, T. J., Jr		Saginaw, E. S., Mich.
1900	Hawkins, B. H	Denver & Rio Grande	Denver, Colo.
1895	Hawksworth, D	Burlington & Missouri River	Plattsmouth, Neb.
1899	Hawthorne, J	Lehigh Valley	Sayre, Pa.
1898	Hayden, J. C	Ferro Carril de Costa Rica	San Jose, Costa Rica.
1896	Hayward, H. S	Pennsylvania	Jersey City, N. J.
1891	Hedley, F	Lake Street Elevated	Chicago, Ill.
1896	Heers, L. B	Pitts., Shaw. & Nor	St. Mary's, Pa.
1887	Heintzleman, T. W	Southern Pacific	Sacramento, Cal.
1888	Hemphill, W. J	Evans. & Howard	St. Louis, Mo.
1892	Henderson, G. R	A. T. & S. F	Topeka, Kan.
1897	Hepburn, G. W	Ches. & Ohio	Covington, Ky.
1892	Herr, Edwin M		Edgewood Park, Pa.
1895	Hibbard, H. Wade	Cornell University	Ithaca, N. Y.
1901	Hickey, P. J	C. C. C. & St. L	Mattoon, Ill.
1890	Higgins, S	Southern	Washington, D. C.
1901	Hildreth, F. F	Terre Haute & Indianapolis	Terre Haute, Ind.
1901	Hilferty, C. D		St. Thomas, Ont.

JOINED.	NAME.	ROAD.	ADDRESS.
1887	Hill, Jas. W	P. & Pekin Union	Peoria, Ill.
1892	Hill, Rufus	Pennsylvania	Pavonia, N. J.
1902	Hillman, C. R	San Paulo	San Paulo, Brazil, S. A.
1900	Hodgkins, W. W	Boston & Maine	Mechanicsville, N. Y.
1899	Hoffman, R. F		Box 774, Schenectady, N. Y.
1901	Hogan, C. H	N. Y. C. & H. R	East Buffalo, N. Y.
1896	Hogsett, C. B		Box 55, Morenci, Graham Co., Arizona.
1892	Holland, W. D	Guayaquil & Quito	Duran, Ecuador, S. A.
1885	Holman, W. L	Pennsylvania	Renova, Pa.
1901	Holtz, D	Western Maryland	Union Bridge, Md.
1890	Homer, John C	C. H. & D	Cincinnati, Ohio.
1900	Hone, A. C	Louisville & Nashville	Louisville, Ky.
1896	Hopwood, Jno	Argentine Gt. West., Mendoza, Argentine Rep., S. A.	
1896	Horrigan, Jno	E. J. & E	Joliet, Ill.
1892	Howard, C. H		504 Columbia Bldg., St. Louis, Mo.
1896	Howard, Jno	N. Y. C. & H. R	Depew, N. Y.
1890	Hudson, E. E		
1899	Hudson, H. G		135 Broadway, Alliance, Ohio.
1892	Hudson, W. H		Spencer, N. C.
1890	Hufsmith, F	I. & G. N	Palestine, Tex.
1890	Humphrey, A. L	Chicago & Alton	Bloomington, Ill.
1901	Hutchinson, C. B	Boston & Maine	Lyndonville, Vt.
1896	Hyndman, F. T	Buffalo, Rochester & Pittsburg	Du Bois, Pa.
1900	Impett, J. J	Cent. R'y of Peru	Lima, Peru, S. A.
1896	Inge, T. S		Columbia, S. C.
1900	Irwin, J. E	Marietta, Columbus & Clevel'd	Marietta, Ohio.
1888	Jackson, O. H	Indianapolis Union	Indianapolis, Ind.
1899	James, E. T	Lehigh Valley	Wilkesbarre, Pa.
1896	James, Geo	N. Y. C. & St. L	Sta. S, Chicago.
1902	Jenkins, Wm	So. Car. & Ga. Ext	Blacksburg, S. C.
1900	Jennings, Thos	Boston & Maine	Keene, N. H.
1890	Jennings, Wm	Mexican International	Ciudad Porfirio, Diaz, Mex.
1896	Johnson, A. B		Baldwin Loco. Works, Philadelphia, Pa.
1902	Johnson, Ben	Mexican Central	City of Mexico.
1878	Johnson, J. B	Arkansas Midland	Helena, Ark.
1887	Johnson, L. R	Canadian Pacific	Montreal, Canada.
1898	Johnson, R. H	Wiggins Ferry Co	St. Louis, Mo.
1888	Joughins, G. R	Santa Fe Pacific	San Bernardino, Cal.
1896	Justice, D. J		
1890	Kalbaugh, I. N	W. Virginia Cent. & Pittsburg	Elkins, W. Va.
1892	Keegan, Jas. E	G. R. & Ind	Grand Rapids, Mich.
1890	Keith, J. M	W. R'y of Gautemala	San Filipe, Gautemala, C. A.
1896	Kells, Willard	Erie	Meadville, Pa.
1896	Kelly, Wm	Great Northern	Everett, Wash.
1894	Kennedy, Jas	Jamaica	Kingston, Jamaica.
1893	Kenney, Geo. W		Rutland, Vt.
1901	Keyworth, T. E	Cuban Central R'ys, Ltd	Sagua La Grande, Cuba.
1890	Killen, W. E	C. P. & St. L. Alton Terminal	Jacksonville, Ill.
1900	Kilpatrick, R. F	Dela., Lack. & Western	Kingsland, N. J.
1898	King, D. M		Raleigh, N. C.
1902	Kipp, A. R	Wisconsin Central	Fond du Lac, Wis.
1892	Kirk, John		Pueblo, Colo.
1892	Kistler, Lewis		Syracuse, N. Y.

JOINED.	NAME.	ROAD.	ADDRESS.
1900	Knapp, E. W		
1890	Knapp, G	Humeston & Shenandoah	Shenandoah, Iowa.
1899	Knapp, L. I		515 So. Franklin st., Kirksville, Mo.
1902	Knight, Wm. Edw	United Railways of Havana	Havana, Cuba.
1902	Krauss, J. I	Louisiana & Northwest	Gibsland, La.
1899	Kummer, W. M		409 Litchfield st., West Bay City, Mich.
1899	Lachlan, Wm	E de F. Porto Alegre & New Hamburg,	Porto Alegre, Rio Grande de Sul, Brazil.
1902	Lahey, John	Kansas City Southern	Shreveport, La.
1898	Laing, W		Texarkana, Tex.
1900	Laird, Alex	Little Kanawha	Parkersburg, W. Va.
1898	Lake, E. M	Honduras	Puero Cortez, Honduras, C. A.
1894	Lang, V. B	Alabama Great Southern	Birmingham, Ala.
1899	Langston, C. J		
1888	Lape, C. F	So. Cal.	San Bernardino, Cal.
1895	Lauer, F. G		Du Bois, Pa.
1891	Lawler, F. M	C. C. C. & St. L	Brightwood, Ind.
1891	Lawes, T. A	C. & E. I	Danville, Ill.
1896	Lawrence, J. L	Cumb. Valley	Chambersburg, Pa.
1901	Layman, W. W		Parkersburg, W. Va.
1890	Leach, H. L		Room 45, Mason Bldg., Boston, Mass.
1892	Lee, C. W		Greensboro, N. C.
1883	Leeds, Pulaski	Louisville & Nashville	Louisville, Ky.
1888	Leigh, F. J		30 Kenilworth Road, Ealing, London W., Eng.
1890	Leonard, A. G	Union Stock Yards	Chicago, Ill.
1876	Lewis, W. H	Norfolk & Western	Roanoke, Va.
1896	Lindoff, Geo		
1896	Linstrom, Chas	Yazoo & Miss. Valley	Vicksburg, Miss.
1890	Lloyd, T. S	Dela., Lack. & West	Scranton, Pa.
1895	Lonergan, P. T.	Rutland	Rutland, Vt.
1899	Lovell, Alfred	A. T. & S. F	Topeka, Kan.
1900	Lowell, W. W	Han. & St. Joseph	Brookfield, Mo.
1897	Lucas, W. O	Central Argentine	Rosario, Arg. Rep., S. A.
1894	Lyon, Tracy	Chicago, Great Western	St. Paul, Minn.
1887	Macbeth, Jas	N. Y. Central	East Buffalo, N. Y.
1890	Macfarlane, T. W		Lock Box 786, Tacoma, Wash.
1899	Machesney, A. G		Baldwin Loco. Works, Philadelphia, Pa.
1876	Mackenzie, John		Cleveland, Ohio.
1892	Mackinnon, Geo. S	Canadian Pacific	Winnipeg, Man., Canada.
1896	Maher, P	Indiana, Illinois & Iowa	Kankakee, Ill.
1896	Mahl, F. W	Southern Pacific	Sacramento, Cal.
1899	Malone, I. M	Ulua Commercial Co	Puerto Cortez, Honduras.
1895	Mallinson, E. P		49 Ashford st., Brooklyn, N. Y.
1894	Manchester, A. E	C. M. & St. P	West Milwaukee, Wis.
1902	Manchester, H. C	Boston & Maine	Mechanicsville, N. Y.
1893	Manning, J. H		348 Halsted st., Chicago, Ill.
1898	Marchbanks, James	Wellington & Manawatu	Wellington, N. Z.
1896	Marden, J. W	Boston & Maine	Boston, Mass.
1897	Marshall, B. F		Mt. Vernon, Ohio.
1890	Marshall, E. S		S. A., American Steel Foundry Co., St. Louis, Mo.
1891	Marshall, W. H	Lake Shore & Michigan South'n.	Cleveland, Ohio.
1888	Maver, A. A	Grand Trunk	Montreal, Can.
1891	McConnell, J. H		American Loco. Co., Pittsburg, Pa.
1896	McCormick, A	Chicago, Rock Island & Pac.	Trenton, Mo.
1892	McCuen, J. P	C. N. O. & T. P	Ludlow, Ky.

JOINED.	NAME.	ROAD.	ADDRESS.
1891	McDonough, James	Gulf, Colorado & S. F	Temple, Tex.
1892	McDuff, Allan	B. C. R. & N	Cedar Rapids, Iowa.
1893	McElvaney, C. T		American Cotton Co., Denison, Tex.
1890	McIntosh, Wm	Central R. R. of N. J	Jersey City, N. J.
1893	McKee, G. S	Mobile & Ohio	Mobile, Ala.
1901	McKeen, W. R., Jr	Union Pacific	Omaha, Neb.
1896	McLean, W. J	Bell. Bay & Brit. Col	New Whatcom, Wash.
1901	McLeish, W. J	Evansville & Terre Haute	Evansville, Ind.
1894	McMasters, Chas. J	Ogdensburg & Lake Champlain	Malone, N. Y.
1896	McNabb, T	Great Falls & Canada	Great Falls, Mont.
1890	McNaughton, Jas		Amer. Loco. Co., Dunkirk, N. Y.
1899	Meagher, W. A		Box 413, Beaumont, Tex.
1901	Meaney, H. M		
1888	Medway, John		33 Lexington ave., Cambridge, Mass.
1895	Mellin, C. J		Amer. Loco. Co., Richmond, Va.
1900	Mendenhall, C. M		Pressed Steel Car Co., Allegheny, Pa.
1892	Mertsheimer, F	Denver & Rio Grande	Denver, Colo.
1887	Michael, J. B	Southern	Knoxville, Tenn.
1883	Middleton, Harvey		8 Read st., Baltimore, Md.
1885	Millen, Thos	Metropolitan Street R'y	106 W. 51st st., New York.
1889	Miller, E. A	N. Y. C. & St. L	Conneaut, Ohio.
1890	Miller, Geo. A	Florida East Coast	St. Augustine, Fla.
1896	Miller, G. W	Erie	Elmira, N. Y.
1901	Miller, S. W	Pennsylvania Lines	Indianapolis, Ind.
1893	Minshull, P. H	N. Y. O. & W	Middletown, N. Y.
1892	Minto, H. M	Louisville & Nashville	Mobile, Ala.
1888	Minton, A. B	Mobile & Ohio	Jackson, Tenn.
1892	Mitchell, Alva	A. T. & S. F	Chanute, Kan.
1892	Mitchell, A. E	Northern Pacific	St. Paul, Minn.
1898	Moler, A. L	Vicksburg, Shreveport & Pac	Monroe, La.
1901	Monahan, J. J	Louisville & Nashville	Paris, Tenn.
1890	Monkhouse, H	Compressed Air Co. of New York, Rome, N. Y.	
1884	Montgomery, Wm	Cent. of N. J	Lakehurst, N. J.
1901	Morgan, J. B	Toledo & Ohio Central	Bucyrus, Ohio.
1900	Morton, G. C	Natl. Tehuantepec	Coatzacoalcos, V. C., Mex.
1890	Moore, J. H	Erie	Buffalo, N. Y.
1895	Moraga, Anselmo	Chilian State	Santiago, Chili.
1896	Moran, Robt	Louisville & Nashville	Nashville, Tenn.
1887	Morris, W. S	Erie	Meadville, Pa.
1898	Morrison, J. F	South Side Elevated	Chicago, Ill.
1901	Morse, C. S	Wheeling & Lake Erie	Ironville, Ohio.
1890	Morse, F. W	Grand Trunk	Montreal, Canada.
1901	Muchnic, C. M	Denver & Rio Grande	Denver, Colo.
1899	Muhlfeld, J. E	Intercolonial	Moncton, N. B., Can.
1890	Murphy, P. H		Murphy Car Roof Co., East St. Louis, Ill.
1894	Nettleton, W. A		Topeka, Kan.
1898	Neubert, G. T	Kansas City Belt	Kansas City, Mo.
1892	Neuffer, John G	B. & O. S.-W	Cincinnati, Ohio.
1901	Neville, John		San Luis Potosi, Mexico.
1898	Newell, T. W		
1896	Neward, F. H	Pontiac, Ox. & Northern	Pontiac, Mich.
1890	Nicholls, J. Mayne	Nitrate R'ys	Iquique, Chili.
1875	Noble, L. C		A. French Spring Co., 1414 Fisher Bldg., Chicago.
1902	Nolan, J. C	Southern Arkansas	Ruston, La.
1899	Nolan, J. P	Southern Pacific	Algiers, La.
1896	Norsworthy, N. W	Norfolk & Western	Crewe, Va.

JOINED.	NAME.	ROAD.	ADDRESS.
1902	Nutt, Geo. B	Queensland Govt. R'ys	Brisbane, Queensland.
1896	Nuttall, W. H	Manistee & N. East'n	Manistee, Mich.
1890	O'Brien, John	Rich. & Petersburg	Manchester, Va.
1890	O'Herin, Wm	Mo., Kan. & Tex	Parsons, Kan.
1895	O'Leary, D	Pacific Coast Co	Seattle, Wash.
1901	Ord, C. R	Canadian Pacific	McAdam Junction, N. B., Can.
1895	Orland, W. P		Mattoon, Ill.
1897	Osborne, H	Canadian Pacific	Montreal, Can.
1897	Owens, W. H	Southern	Manchester, Va.
1901	Parish, L. G	L. S. & M. S	Englewood, Ill.
1900	Parker, M. B	Rockwood & Tenn. River	Rockwood, Tenn.
1901	Park, S. T	Southern California	San Bernardino, Cal.
1891	Pattee, J. O		St. Louis, Mo.
1879	Patterson, J. S		Galena Oil Co., Cincinnati, Ohio.
1891	Paxton, Thos	Colorado & Southern	Denver, Colo.
1899	Pearse, H	Buenos Ayres & Rosario	Campana, Arg. Rep., S. A.
1887	Peck, Peter H	C. & W. I. and Belt	Chicago, Ill.
1901	Pengelly, J. H	Mexican International	Durango, Mex.
1899	Pennington, J. H	Dela., Susq. & Schuyl	Drifton, Pa.
1897	Peyton, H. T	Atchison, Topeka & Santa Fe	Wellington, Kan.
1897	Pflager, H. M		385 Wabash ave., Chicago, Ill.
1900	Phillips, C	New Orleans & Northeastern	Meridian, Miss.
1902	Pilcher, J. A	Norfolk & Western	Roanoke, Va.
1885	Pitkin, A. J		American Loco. Co., 25 Broad st., New York.
1901	Place, F. E	Illinois Central	Burnside Shops, Chicago.
1874	Place, T. W		Waterloo, Iowa.
1900	Plank, P. D	Louis., Hend. & St. L	Cloverport, Ky.
1881	Player, John		Franklin, Pa.
1897	Pollitt, Harry	Great Central	Fernlea, Altricham, Cheshire, Eng.
1900	Post, W. F		Watkins Fdy & Mch. Co., Hattiesburg, Miss.
1897	Potton, J	Texas & Pacific	Big Springs, Tex.
1891	Prescott, C. H	Spokane Falls & Nor	Spokane, Wash.
1900	Prince, S. F., Jr	Philadelphia & Reading	Reading, Pa.
1881	Pringle, R. M		Second and Carr sts., St. Louis, Mo.
1902	Punshon, Eli	Kansas City So	Pittsburg, Kan.
1890	Purves, T. B., Jr	Boston & Albany	Boston, Mass.
1888	Quayle, Robert	Chicago & North-Western	Chicago, Ill.
1895	Quereau, C. H	N. Y. C. & H. R	W. Albany, N. Y.
1888	Quinn, John A	Chesapeake & Ohio	Clifton Forge, Va.
1896	Rainsford, Henry J		Anaconda, Mont.
1890	Randolph, L. S		Virginia Polytechnic Institute, Blacksburg, Va.
1891	Rearden, Frank		Lincoln Trust Bldg., St. Louis, Mo.
1901	Redding, D. J	P. & L. E	McKee's Rocks, Pa.
1888	Reed, W. T		Portsmouth, Va.
1902	Reid, W. L		American Loco. Co., Dunkirk, N. Y.
1901	Rennie, Robt	D. & H. C	Carbondale, Pa.
1883	Renshaw, W	Illinois Central	Chicago, Ill.
1892	Rettew, C. E	D. & H. C	Carbondale, Pa.
8961	Reynolds, O. H		American Loco. Co., New York Ctty.
1887	Rhodes, G. W	Burlington & Missouri River	Lincoln, Neb.
1899	Rhodes, L. B	Georgia Southern & Florida	Macon, Ga.
1901	Richmond, W. H	Lake Superior & Ishpeming	Marquette, Mich.
1897	Rickert, Mason		Delaware, Ohio.

[illegible]	NAME.	ROAD.	ADDRESS.
[illegible]	[illegible]	McKeesport Connecting	Pittsburg, Pa.
[illegible]	[illegible]	Atchison, Topeka & Santa Fe	Topeka, Kan.
[illegible]	[illegible]	Grand Trunk	Montreal, P. Q.
[illegible]	[illegible]		Springfield, Ohio.
[illegible]	[illegible]	Union Pacific	Kansas City, Kan.
[illegible]	[illegible]		1124 Cornell ave., Indianapolis, Ind.
[illegible]	[illegible]	Kansas City Southern	Pittsburg, Kan.
[illegible]	Robinson, Frank	Maine Central	Bangor, Me.
[illegible]	[illegible]	Southern	Spencer, N. C.
[illegible]	[illegible]	Little Rock & Memphis	Argenta, Ark.
[illegible]	[illegible]		1008 West 24th st., Kansas City, Mo.
[illegible]	[illegible]	Halifax & Yarmouth	Yarmouth, N. S., Canada.
[illegible]	[illegible]	R. & O. Ins. Amer. Loco. Co.	Richmond, Va.
[illegible]	[illegible]	Great Northern	St. Paul, Minn.
[illegible]	[illegible]	Illinois Central	Chicago, Ill.
[illegible]	[illegible]	Western Australian Govt. R'ys	Tremantle, Australia.
[illegible]	[illegible]		[illegible] Old Colony Bldg., Chicago, Ill.
[illegible]	[illegible]		Box [illegible], Susquehanna, Pa.
[illegible]	[illegible]	Buffalo, Rochester & Pittsburg	Bradford, Pa.
[illegible]	[illegible]	[illegible] Houston & San Antonio	San Antonio, Tex.
[illegible]	[illegible]	Louisville & Nashville	Russellville, Ky.
[illegible]	[illegible]	Southern Pacific	Houston, Tex.
[illegible]	[illegible]		Falls Village, Conn.
[illegible]	[illegible]	[illegible]	[illegible] Broad st., New York.
[illegible]	[illegible]	[illegible]	[illegible] Works, Philadelphia, Pa.
[illegible]	[illegible]	[illegible]	Brainerd, Minn.
[illegible]	[illegible]	[illegible]	Portsmouth, Va.
[illegible]	[illegible]	[illegible]	Lambert's Point, Va.
[illegible]	[illegible]	[illegible]	[illegible]

JOINED.	NAME.	ROAD.	ADDRESS.
1892	Smith, John L	Buffalo, Rochester & Pittsburg	Du Bois, Pa.
1900	Smith, L. L	Chicago Great Western	Fort Dodge, Iowa.
1899	Smith, R. D	Burlington & Mo. River	Lincoln, Neb.
1891	Smith, Wm	Duluth, Missabe & Nor	Proctor Knott, Minn.
1902	Smith, Wm	N. Y. Cent. & Hudson River	Mott Haven, N. Y.
1869	Smith, W. T	Chesapeake & Ohio	Richmond, Va.
1891	Soule, R. H		917 Seventh ave., New York City.
1899	Spillard, L. H		Apartado 447, City of Mexico.
1897	Spragge, Jos. R	Canadian Pacific	Toronto Junc., Ont., Can.
1895	Sprigg, Z. T	Union Pacific	Denver, Colo.
1901	Sprowl, N. E	Southern	Columbia, S. C.
1901	Squire, W. C		Springfield, Mo.
1898	Stansbury, C. M	Chicago & Eastern Illinois	Dalton Sta., Cook Co., Ill.
1894	Steele, S. A		Weston, W. Va.
1874	Stevens, Geo. W		Elyria, Ohio.
1898	Stevenson, C. E	Mogyana	Campinos, San Paulo, Brazil, S. A.
1892	Stewart, Andrew F	Chesapeake & Ohio	Huntington, W. Va.
1900	Stewart, M. D.	Rio Gr., Sierra Madre & Pac	Ciudad Juarez, Mex.
1885	Stewart, O	Bangor & Aroostook	Oldtown, Maine.
1890	Stillman, H	Southern Pacific	Sacramento, Cal.
1896	Stocks, W. H	Chicago, Rock Island & Pacific	Chicago.
1896	Stout, S. E	Philadelphia & Reading	Philadelphia, Pa.
1890	Studer, A. L	C. R. I. & P	Horton, Kan.
1901	Sullivan, J. J	Louisville & Nashville	Louisville, Ky.
1891	Summerskill, T. A	Vermont Central	St. Albans, Vt.
1892	Sumner, Eben T	Boston & Maine	East Cambridge, Mass.
1899	Suzuki, S	Kinshui	Moji, Japan.
1901	Swoyer, H	Louisville & Nashville	Louisville, Ky.
1899	Symington, T. H		702 Fidelity Bldg., Baltimore, Md.
1892	Symons, W. E	Gulf, Colorado & Santa Fe	Cleburne, Texas.
1902	Tabor, A. E	Montana Central	Great Falls, Can.
1894	Taft, Wm. H	Boston & Albany	Allston, Mass.
1883	Tandy, H		Supt. Canadian Loco. Works, Kingston, Ont., Can.
1896	Tawse, Robt	Ann Arbor	Owosso, Mich.
1893	Taylor, C. M	Atchison, Topeka & Santa Fe	La Junta, Colo.
1900	Taylor, G. W	Torbert & Peckham	Davenport, Iowa.
1901	Taylor, H. D	Lehigh Valley	So. Bethlehem, Pa.
1896	Taylor, Jno	C. M. & St. P	Minneapolis, Minn.
1893	Taylor, Wm. H	N. Y., Susquehanna & Western	Stroudsburg, Pa.
1901	Templeton, W. S	Southern Pac. Co	San Luis Obispo, Cal.
1885	Thomas, C. F	Southern	Columbia, S. C.
1891	Thomas, H. T	Detroit & Mackinac	East Tawas, Mich.
1892	Thomas, J. J., Jr	Seaboard Air Line	Savannah, Ga.
1883	Thomas, W. H	Southern	Washington, D. C.
1901	Thomas, W. T	Cleve. Cin. Chi. & St. Louis	Mt. Carmel, Ill.
1890	Thompson, C. A		Morris Park, Long Island, N. Y.
1896	Thompson, Geo	Union Pacific	Omaha, Neb.
1895	Thompson, W. T.	Rapid Transit Subway Const. Co.	Park Row Bldg., New York.
1902	Thompson, W. O	N. Y. Cent. & Hudson River	Oswego, N. Y.
1883	Thow, Wm	Government	Eveleigh, N. S. W.
1902	Thornton, Chas. J	United R'ys of Havana	Havana, Cuba.
1892	Todd, Louis C	Boston & Maine	Charlestown, Mass.
1898	Tollerton, W. J	Oregon Short Line	Salt Lake City, Utah.
1901	Toltz, Max	Great Northern	St. Paul, Minn.
1897	Tomlinson, J. J	Mex. Northern	Escalon, Chihuahua, Mex.
1893	Tonge, John	Minneapolis & St. Louis	Minneapolis, Minn.

JOINED.	NAME.	ROAD.	ADDRESS.
1900	Tonkins, W. H	Lima	Calloa, Peru, S. A.
1896	Tower, G. M		
1892	Townsend, Jos		Bloomington, Ill.
1896	Tracy, W. L	Southern	Atlanta, Ga.
1892	Traver, W. H		Rand Drill Co., Monadnock Block, Chicago, Ill.
1883	Tregelles, Henry		Care Norton, Megaw & Co., Rio de Janeiro, Brazil.
1892	Tremp, A. E		Matthews, Ind.
1896	Tubbs, F. E		1018 W. Duval st., Jacksonville, Fla.
1890	Tuggle, S. R	Houston & Texas Central	Houston, Tex.
1899	Turner, A	Lehigh Valley	South Easton, Pa.
1890	Turner, Calvin G	Phil. Wil. & Balto	Wilmington, Del.
1889	Turner, Chas. E	B. R. & P	Rochester, N. Y.
1886	Turner, J. S		Room 18, 160 Broadway, New York City.
1890	Turner, L. H	Pittsburg & Lake Erie	Pittsburg, Pa.
1886	Twombly, A. W	N. Y. N. H. & H	Taunton, Mass.
1883	Twombly, Fred M	N. Y. N. H. & H	Roxbury, Mass.
1887	Tynan, F. F		Hotel Trocha, Vidado, Havana, Cuba.
1890	Tyrrell, Thos. H	Staten Island Rapid Transit	Whitehall st., N. Y. City.
1889	Vail, A	Pennsylvania	Buffalo, N. Y.
1898	Van Alstine, D	Chicago Great Western	St. Paul, Minn.
1890	Van Brunt, G. E	Pennsylvania & N.-Western	Bellwood, Pa.
1896	Van Cleve, J. R	White Pass & Yukon	Skagway, Alaska.
1891	Vauclain, Samuel M		Baldwin Loco. Works, Philadelphia, Pa.
1898	Vaughan, H. H	Lake Shore & Mich. So	Cleveland, Ohio.
1896	Villasenor, Alberto		San Jose de Costa Rica, C. A.
1892	Vogt, A. S	Pennsylvania	Altoona, Pa.
1899	Vought, J. H	Lehigh Valley	South Bethlehem, Pa.
1892	Waitt, A. M	N. Y. Central & Hudson River	New York, N. Y.
1900	Walker, E. S	Illinois Southern	Sparta, Ill.
1893	Walker, Henry E		Beyer, Peacock & Co., Gorton, Manchester, Eng.
1891	Wallis, J. M	Pennsylvania	Altoona, Pa.
1888	Wallis, Phillip	Long Island	Richmond Hill, L. I., N. Y.
1900	Walsh, F. O	A. & W. P., W. R'y of Ala	Montgomery, Ala.
1874	Walsh, Thos	Louisville & Nashville	Howell, Ind.
1902	Walsh, W. C	Southern Indiana	Bedford, Ind.
1896	Walton, E. A	N. Y. Cent. & Hudson River	Corning, N. Y.
1896	Ward, C. A		Bangor, Pa.
1887	Ward, C. F	C. St. P. M. & O	1517 Madison ave., Omaha, Neb.
1883	Warren, Beriah		1619 Pennsylvania ave., St. Louis, Mo.
1882	Warren, W. B	St. Louis & Gulf	Cape Girardeau, Mo.
1902	Watson, Samuel	N. Y. Cent. & Hudson River	W. Albany, N. Y.
1883	Watts, Amos H	Detroit Southern	Springfield, Ohio.
1896	Waugh, L. H		Cleburne, Tex.
1887	Webb, F. W	London & North Western	Crewe, England.
1892	Weiss, C. P		American Loco. Co., Richmond, Va.
1886	Weisgerber, E. L	Baltimore & Ohio	Mt. Clare Shops, Baltimore, Md.
1900	Welch, C. H	Choc. Okla. & Gulf	Little Rock, Ark.
1896	West, A. T. (M. M.)		Tabor, Iowa.
1880	West, G. W	N. Y. O. & W	Middletown, N. Y.
1899	Westmark, H. O		144 N. Lake st., Aurora, Ill.
1885	White, A. M		20 Union ave., Schenectady, N. Y.
1894	White, E. T	Baltimore & Ohio	Mt. Clare, Baltimore, Md.
1901	White, W	Lake Erie & Western	Lima, Ohio.
1898	Whyte, F. M	N. Y. Central & Hudson River	New York.
1899	Wiest, E. N	Man. & North-Eastern	Manistee, Mich.

JOINED.	NAME.	ROAD.	ADDRESS.
1894	Wiggin, Chas. H	Boston & Maine	Boston, Mass.
1884	Wightman, D. A		Warren, R. I.
1900	Wilbur, I. N	Han. & St. Joseph	Hannibal, Mo.
1891	Wilcox, W. J	Mexican Central	Monterey, Mex.
1901	Wildin, G. W	C. R. R. of N. J	Jersey City, N. J.
1896	Williams, Alfred	Paulista	Paulista, Brazil, S. A.
1891	Williams, E. A	Canadian Pacific	Montreal, P. Q.
1887	Wilson, G. F	C. R. I. & P	Chicago, Ill.
1901	Wilson, W. H	Erie	Dunmore, Pa.
1900	Wirt, G	C. C. C. & St. L	Delaware, Ohio.
1900	Withers, A. B		304 So. Church st., Charlotte, N. C.
1898	Witmer, J. W		350 W. North st., Lima, Ohio.
1901	Wright, R. V	Pittsburg & Lake Erie	Pittsburg, Pa.
1896	Yohn, C. R	H. & B. T. Mtn	Saxton, Pa.
1899	York, F. C	B. A. & Pac. Estacon Junin,	Buenos Ayres, Arg. Rep., S. A.
1902	Young, C. B	Chicago, Burlington & Quincy	Chicago, Ill.
1895	Young, W. H	Atlantic Coast Line	Savannah, Ga.
1898	Zerbee, F. J	C. C. C. & St. L	Bellefontaine, Ohio.

ASSOCIATE MEMBERS.

JOINED.	NAME.	ADDRESS.
1893	Baker, Geo. H	425 Summer ave., Brooklyn, N. Y.
1898	Basford, G. M	Morse Bldg., New York City.
1898	Bates, E. C	Crosby Steam Gauge & Valve Co., Boston, Mass.
1890	Crossman, W. D	Western Roofing & Supply Co., 195 Lake st., Chicago, Ill.
1883	Dean, F. W	55 State st., Boston, Mass.
1896	Fowler, Geo. L	53 Broadway, New York City.
1880	Gordon, Alex	Niles Tool Works, Hamilton, Ohio.
1895	Goss, W. F. M	Purdue University, Lafayette, Ind.
1889	Hill, John A	80 Munn ave., E. Orange, N. J.
1899	Kneass, Strickland L	Wm. Sellers Co., Ltd., Philadelphia, Pa.
1901	Lane, F. W	*Railway Age*, Monadnock Bldg., Chicago, Ill.
1901	Player, John	American Loco. Co. Brooks Works, Dunkirk, N. Y.
1889	Pomeroy, L. R	General Electric Co., 44 Broad st., New York City.
1893	Robinson, Harry P	Monadnock Bldg., Chicago, Ill.
1899	Smart, R. A	B. F. Sturdevant Co., Boston, Mass.
1889	Smith, John Y	
1882	Smith, W. A	Manhattan Bldg., Chicago, Ill.
1899	Street, Clement F	Wellman-Seaver-Morgan Eng. Co., Cleveland, Ohio.

HONORARY MEMBERS.

JOINED.	NAME.	ROAD.	ADDRESS.
1883	Blackwell, Chas		Mt. Lookout, Cincinnati, Ohio.
1869	Boon, J. M		5117 Madison ave., Chicago, Ill.
1879	Cooke, Allen		Danville, Ill.
1869	Coolidge G. A		Barnard ave., Watertown, Mass.
1870	Cooper, H. L		Morgan Park, Ill.
1895	Coster, E. L	Assistant in Mechanical Engineering Columbia Univers'y. Residence, Irvington on Hudson.	25 Broad st., New York City.
1870	Divine, J. F	W. & Weldon	Wilmington, N. C.
1881	Eastman, A. G		Sutton, Que.
1871	Forney, M. N		501 Fifth ave., New York City.
1872	Foss, J. M	Cent. Vermont	St. Albans, Vt.
1885	Galloway, A	C. H. & D	Cincinnati, Ohio.
1871	Hewitt, John		1323 So. Jefferson st., St. Louis, Mo.
1870	Hodgman, S. A		Lobdell Car Wheel Works, Wilmington, Dela.
1874	Jeffery, E. T	Denver & Rio Grande	Denver, Colo.
1868	Johan, Jacob		515 So. State st., Springfield, Ill.
1868	Kinsey, J. I	Lehigh Valley	Easton, Pa.
1873	Lewis, W. H		Hoboken, N. J.
1878	Maglenn, Jas	Seaboard Air Line	Raleigh, N. C.
1869	McKenna, John	I. D. & S. W	Indianapolis, Ind.
1871	Miles, F. B		Bement & Miles, Philadelphia, Pa.
1885	Paxson, L B	P. & R	Reading, Pa.
1872	Philbric, J. W		Waterville, Me.
1878	Pilsbury, Amos		Portland, Me.
1873	Prescott, G. H		Logansport, Ind.
1869	Richards, George		14 Auburn st., Roxbury, Mass.
1870	Robinson, W. A		Hamilton, Ont.
1869	Sellers, Morris		Western Union Bldg., Chicago, Ill.
1868	Shaver, D. O		Pittsburg, Pa.
1888	Sheppard, F. L	Pennsylvania	Altoona, Pa.
1891	Sheer, J. M		514 Seventh st., E. St. Louis, Ill.
1868	Sprague, H. N		Jamestown, N. Y.
1869	Stechel, J. H		Cuba, N. Y.
1875	Strode, Jas		Elmira, N. Y.
1883	Sullivan, A. W	Illinois Central	Chicago, Ill.
1868	Swanston, Wm		69 Woodruff place, Indianapolis, Ind.
1869	Thompson, John		137 Webster st., E. Boston, Mass.
1870	Towne, H. A		54 S. Third st., Minneapolis, Minn.
1868	Wells, Reuben		Paterson, N. J.

PROCEEDINGS.

The Thirty-fifth Annual Convention of the American Railway Master Mechanics' Association was called to order at 9:30 A.M. on Monday, June 23, 1902, in the ballroom of the Grand Union Hotel, Saratoga Springs, N. Y., by President A. M. Waitt.

Prayer was offered by the Rev. Tillotson F. Chambers, pastor of the First Baptist Church of Saratoga Springs.

THE PRESIDENT: In opening this, our thirty-fifth annual convention, the village of Saratoga, through its President, Mr. A. W. Knapp, desires to extend to us a welcome, and I will now call upon Mr. Knapp, President of the village, to address us.

MR. KNAPP: Mr. President, ladies and gentlemen of the American Railway Master Mechanics' Association,—As president of the village of Saratoga Springs it gives me very great pleasure to again meet and welcome the members of your Association on the occasion of your thirty-fifth convention, and I believe the sixth time you have met in Saratoga Springs.

The president of your twin association, the Master Car Builders' Association, in opening the convention the other morning, introduced me as the president of the village and said if the consent of the president of the village to open the convention was not obtained, the convention would be obliged to go to Boston. We assume, in that calamitous event, the Master Mechanics would have gone with them, and I am glad to have been the instrumentality of saving these two conventions from the suffering entailed in meeting in Boston, where the curfew rings at 11 o'clock at night. (Laughter.)

Among the pleasant things that fall within the duty of the president of the village is in meeting distinguished bodies of men, and it compensates for some of the annoyances which necessarily

come to all city officials. We have many annoying things happen to us, if you will permit me to mention it. Sometimes, however, these annoying things have humorous sides to them which are interesting. The other day a citizen called upon me with a complaint that the bursting of a water main had filled his cellar with water and drowned his chickens. I sent him to the president of the Sewer and Water Board, and about three days afterward he came back with the same story. I said: "I told you to go to the sewer and water board." He answered, "I did." "What did they tell you?" "They told me I had better keep ducks." (Laughter and applause.)

Mr. President and gentlemen,—I assure you that Saratoga Springs appreciates the honor of your presence here. Your assembling among us is a great help to us in the hard and strenuous fight we have for existence, with our short season. Your coming here, at the opening of the season, with your busy, active and strenuous ways, stimulates us and it is an inspiration to us to go and make the fight of our lives for existence.

I trust, Mr. President and gentlemen, that your convention will be in every way successful. The Master Car Builders' Association exhausted all the bad weather, and we trust it will be pleasant during your stay. I am not going to take up your time, as you have matters of greater importance than listening to an address by the president of the village of Saratoga. (Applause.)

THE PRESIDENT: Mr. Knapp, we appreciate your kindly words, and we hope Saratoga Springs will be benefited by our presence as well as that the members and guests of the Association will be benefited by their being here.

The next in order is the address of the President.

President Waitt read the following address:

Members of the American Railway Master Mechanics' Association, Ladies and Gentlemen:

It affords me great pleasure at the opening of this, the thirty-fifth annual convention of this Association, to extend to you all a hearty personal greeting. The appreciation of Saratoga as an ideal convention meeting place is shown by our return to this delightful spot for the sixth time. We have always found a hearty welcome extended to us here, and an atmosphere which has been conducive to a full attendance and effective work. It is to be hoped that this meeting will fully maintain the record of the past, and

that at its close we can congratulate ourselves upon its having been our best and most valuable convention.

The past year has been one of uninterrupted progress and prosperity in all lines of business, so much so, that the railroads of the country have been taxed to the utmost of their capacity to care for the enormously increased traffic, and our newspapers have been continually compelled to chronicle a car and motive power famine. The various manufacturing plants for locomotives and cars have been taxed to their utmost capacity, and although heretofore considered to be of ample size, have been extensively added to, and notwithstanding this, at the present time, the space for new construction of motive power is taken up far along into 1903.

Statistics compiled for the year 1901 showed the total output of the eight principal locomotive building plants of this country as 3,384. This was the largest output on record, and is 7 3-10 per cent more than in 1900. For the year ending June 1, 1902, the record of locomotive building has exceeded even the year 1901, the reports of five locomotive manufacturing companies indicating an output of 3,638, which is a total result beyond what has ever before been reached. Of these locomotives about 540 were for passenger service, 2,380 freight service, and the balance for switching and miscellaneous uses. Eighty per cent. were for use of bituminous coal; 10 per cent. for anthracite, and the balance, 10 per cent., for oil or other fuels. Of the bituminous coal-burning standard-gauge engines about 50 per cent. were constructed with so-called wide fire boxes, extending beyond the outside of frames. During the past year about 30 per cent. of the total of passenger and freight engines built by the two largest locomotive manufacturing companies were of the compound type. The heaviest engine built during the past year weighed, not including the tender, 267,800 pounds; 237,800 pounds of which were on the driving wheels. This was a locomotive of the decapod type, built for heavy service on the Atchison, Topeka & Santa Fe Railway.

The past five years have shown a wonderful development in the main features of locomotive design and construction. No longer ago than 1897, passenger engines with 2,200 feet of heating surface, and freight engines with 2,900 feet, were spoken of as marvels of progress, and comment was made at that time of the fact that boiler pressures were being raised to above 150 pounds, and might possibly reach 180 pounds on simple locomotives. The past year engines have been constructed for passenger service with over 3,500 feet of heating surface, and freight engines with 5,390 feet. Most of the simple engines were constructed to carry 200 pounds pressure, and some have been designed for 225 pounds. At the present time it seems to be a conceded fact that with 200 pounds pressure the economical limit for simple engines has been reached, and that for higher pressures the compounding feature is necessary for economy in fuel consumption.

During the past two years the limitations of the two-cylinder compound engine have been reached and passed. The required dimensions for the low-pressure cylinders for two-cylinder type on the heavy engines of recent

construction exceed the possible clearance limits for side tracks and switch stands, and the space between the necessary location of the center of cylinder and top of rail. In the present state of the art two alternatives seem to be presented, namely, the tandem, or the four-cylinder compounds, both of which types have enthusiastic adherents and ardent opponents.

The tendency in locomotive design at present is toward a greatly reduced ratio of the grate surface and heating surface to the weight on drivers for engines burning bituminous coal, and it would appear, from the satisfactory results obtained from locomotives of recent design, that the former standards of good practice recommended by the Association must be materially revised. It is an uncontroverted fact that greater attention is now being given to the careful designing and proper proportioning of locomotives than ever before, and during the past three years the American locomotive has taken long strides ahead as a steam producer and speed maker.

In past years failures to make steam in sufficient quantities to reliably handle heavy passenger trains at high speeds have been rather frequent. This condition has developed the fact that there has been some error in the basis of design of locomotives for heavy or fast service. A little examination of the relation between the heating surface and the work expected from the locomotive will readily indicate the necessity for very different ratios than have been used in past years. It is a conceded fact that the weight on the driving wheels gives the limit to the power that can be exerted by a locomotive in handling a train. It is a known fact that engines designed ten years ago fail for lack of steam when assigned to haul, at fast speeds, trains which they are abundantly able to start. It is known that locomotives designed during the past two years have overcome this difficulty, and make an abundance of steam, so that even with coal poorer in quality than ordinary, and with head winds, and an extra car or two, little difficulty is experienced in producing plenty of steam, and maintaining a fairly uniform pressure. Taking the weight on the drivers as an indicator of the power expected from the locomotive, and assuming a proper proportioning of the cylinder and diameter of drivers for the work to be performed, we must naturally look to the source of steam production, which is the boiler. The amount of steam produced of course depends upon the coal consumed (either economically, or otherwise), and the evaporative efficiency of the boiler. Assuming a boiler of reasonably good design, the evaporative efficiency will be closely proportionate to the amount of effective heating surface provided to conduct the heat from the incandescent fire and hot gases to the water. An analysis of the vital proportions of engines that were considered marvels in their day, ten years ago, shows the ratio of heating surface in square feet to the weight on the drivers in pounds as about 1 to 45 for passenger service. The once-famous 999 of the World's Fair period had the ratio of 1 to 43.5. Engines built with the same weight on drivers for heavy or fast passenger service during the past two years have this ratio 1 to 30.5. Though both are capable of starting trains of corresponding weight, the 1893 class fails in the long run, consumes more

coal per unit of work performed, and as a consequence has been consigned to services without either honor or good record. The 1901 class, with the 1 to 30 ratio, and same driving wheel weight, does more work with less fuel, and with rare failures, and is naturally the idol of the hour. As a suggestion worthy of consideration, and the result of no small amount of observation and computation, let me recommend that in new locomotives designed for the best results under present conditions, that, for passenger service, engines burning bituminous coal should have a ratio of heating surface to weight on drivers not more than 1 to 30. Some of the best working locomotives now in service have this ratio as low as 1 to 27. For heavy freight service, where speed in going over a division of from 100 to 150 miles averages from 15 to 20 miles per hour, the ratio should not exceed 1 to 50. For switching service, where demands for steam are less continuous, a ratio of 1 to 75 will produce excellent results.

For some years past many of the railroad companies have been giving considerable attention to the tonnage rating of engines, until it had, for a time, become almost a fad, and was overdone. It frequently happens, in reform movements, that they are carried to extremes. In the excess of zeal to load engines up to their full rated capacity the factor of average speed and resultant time in getting trains over the road was many times lost sight of, and engines were loaded to a point where they could only just drag the train slowly over the line, resulting in frequent stalling, breaking in two, and greatly increased wear and tear on both power and equipment. Better judgment has shown that slightly lighter loading has resulted in an increased gross engine ton mileage, more satisfactory time record in delivery of freight, greater contentment of enginemen and trainmen, and much less expense for maintenance of engines and for repairs of cars.

All efforts of the executive officers of our railroads have the object in view of increasing the difference between the cost of operation and the revenue received for handling traffic. To my mind, there are several lines of action for advantageous consideration in which the motive power department officials can materially assist in bringing about a decrease in operating expenses and an increase in efficiency of operation.

Prominent among these I would name "*System and Organization*" in department work. The past two or three years have done much towards bringing many lines having independent organizations into more close business relations than heretofore. This has been brought about by consolidations, leasing, purchase, or as a result of the merging of a "community of interests." The result of such moves is to bring about a more uniform general policy; to give better service to the public; to standardize methods and equipment, and to reduce friction. In many cases this has given to executive and operating officers a more extensive jurisdiction and larger duties, and has imposed burdens upon them that call for the establishing of a carefully worked out system and thorough organization for conducting the business delegated to them, if the desired results are to be obtained.

Success, in small matters, may be possible without the necessity for inaugurating system, as in such matters an officer may be able to divide his time and presence so as to come in personal contact wtih much of the detail, but in large affairs, embracing much territory and many men, an executive officer cannot go into much detail, or be in frequent personal contact with but few points.

In handling large business propositions the executive officer must, in order to be successful, inaugurate a thorough system, and he must gather about him an organization of efficient helpers. These subordinates must be of such a character that they can each be relied upon to carry out the part of the systemized work delegated to them, and present to their chief in command such summaries of results as will keep him thoroughly posted as to the work accomplished. These reports should be of such a character as to enable the chief to quickly locate weak points in either the system or the organized force for carrying out the system, so that such weak points can be strengthened by personal contact. Scattered efforts are most often futile. Concentration is needed for success in large matters.

Any system, to be successful, must clearly define duties and the measure of responsibility, so that if a failure occurs there will be no doubt as to who is to be looked to for an explanation, and who is responsible. Lack of good system, or absence of a reliable organization, cause many executive officers to carry burdens and worries which could easily be avoided. Better results could be more rapidly obtained with the expenditure of a little more money for efficient subordinates, enabling the chief to take more time for planning and systematizing the work, and less for the detail that could be done just as readily by assistants.

In "*Good Shop Practice and Methods*" is another source of money saving for railroads. There should be a sufficient number of foremen to properly supervise the quantity and quality of work. The average grade of mechanics, in many of our railroad shops, is considerably below the standard in general manufacturing lines. Although the work is generally more steady and continuous the year round, yet on account of the average pay being less it is found that at certain times of the year, manufacturing shops, outside, can hold out better temporary inducements, and the men are willing to take chances of being able to return to the railroad shops when the outside business is dull. It is almost always the better class of men that leave. As a result of the poor average grade of mechanics, much work is spoiled or poorly fitted, requiring more work in setting up, and giving poor results in service. Much poor work from poor mechanics has to go to the scrap pile. Some way of inducing the better grade of mechanics to seek railroad shop service, and to remain in such service, is desirable. It is noticeable that in shops using the piecework system, if it has been introduced in a fair and liberal spirit, the best grade of men remain in service, and the poorer ones leave voluntarily. Piecework is a boon, alike to the shop superintendent and to the good mechanic, as it gives the mechanic a

much higher net pay per month, and relieves the foreman from having to rush the men in order to get the proper quantity of work turned out.

In introducing piecework it must be done with absolute fairness, and in a manner to show the mechanic that if he maintains a fair output he is guaranteed the equivalent of his day rate of pay, and is given the privilege of greatly increasing his wages by means of an increased output, and will not be curtailed because he puts in unusual efforts, and draws high monthly pay. A piecework basis should be made clearly advantageous to the mechanic, while retaining part of the benefit for the company. A price should be carefully established, and it should be understood that when it is established, it will stand for three, or, better, six months, before revision, unless some material change is made in the tools or facilities for getting out the work. In revisions of prices an equal division may properly be made between the mechanic and the company.

Above all, straightforwardness and fairness, by all concerned, is necessary to success in introducing a piecework system, or any new system affecting relations between the employer and employes.

Much can be done in reducing loss in operation by furnishing good, modern tools, and keeping them in good condition. Experiments with higher grades of tool steel will, in many shops, enable the speed of running the machines to be doubled, or greatly increased, thereby giving much larger output. Greatly improved results can be obtained by giving attention to proper grinding of tools, and proper setting in the tool post.

Care in the selection and purchasing of good material, under carefully prepared specifications, will reduce to a minimum the loss from poor material, and will increase the wear of the parts made.

As has been frequently stated, the cost of coal consumption is the largest single item of expense that the motive power department has to deal with. In order to handle this question to the best advantage, it is necessary to make a careful study of the production and treatment of the coal in detail from the mine to the tender. On many large systems the work of an A1 man, as a specialist, devoting his time to a study of the quality of coal and its handling, would, without doubt, effect a saving of from five to ten per cent.

It is a known fact that the size of locomotives of recent design is such that the limit has almost been reached for the capacity of a single fireman to properly fire the engines. If any further increase in the size of the fire box is contemplated, it may be necessary to install an automatic method of stoking. In many of the engines put in service during the last three years, an automatic stoker would, undoubtedly, be the means of considerable economies in the burning of coal.

A great deal has been said and written in regard to smokeless burning of bituminous coal, and many devices have been presented with that end in view, but none of them, in past years, seems to have met with success. Happily this condition no longer exists, as experiments during the past year have clearly and fully demonstrated that there are one or two prac-

ticable devices in actual operation by means of which the poorest grades of bituminous coal can be burned with absolute freedom from black smoke, and with only an occasional trace of light brown smoke, regardless of whether the engine is working steam or is shut off. On the New York Central & Hudson River Railroad a device of this kind has been in successful operation on one locomotive for about ten months, and since January 1 it has been applied to ten or twelve additional engines, with such success that it has been specified on new equipment. The saving in coal with the smoke consumer is an important feature in its favor. Within a few months past quite a number of roads have had one or more engines equipped with the device referred to, and I am told that gratifying results are realized in every instance. Reports made by road foremen of engines in charge of some of the engines on the New York Central indicate a saving of fifteen to twenty per cent. in service on a division with a 148 mile run.

The recent discovery of large quantities of petroleum in the southwest and on the Pacific coast has almost revolutionized the type of fuel for locomotives on roads in the extreme west, and it has started pointed inquiries and investigations as to the possible economies and advantages of liquid fuel on roads in the middle and eastern States.

In 1896 a committee from this Association made a report on front end arrangements for locomotives, which has been taken by many of the railroads as a standard for practice for a number of years. The development of the enormous proportions of engines to-day has so changed the conditions of operation that it is evident, from experiments made by some of the prominent members of the Association, that the old rules of practice are not applicable to present conditions. The management of the American Engineer and Railroad Journal, seeing that such a condition existed, and that it did not seem feasible at the time for this Association to enter into a somewhat expensive series of locomotive tests, have at their own expense and risk arranged for a careful series of tests being made at Purdue University, to determine for modern front end practice what the fundamental governing rules for draft appliances should be to enable the best and most economical results to be obtained. I desire to commend this work to this Association, and bespeak its hearty co-operation, and the financial co-operation of the roads which are represented here.

I wish to call attention to the helpfulness of the work of the various associations representing specific lines of work under the jurisdiction of the motive power departments of our railroads, among others, the traveling engineers, air brake men, blacksmiths, boilermakers and painters. I would recommend that this Association and the individuals composing it give all aid and coöperation possible in furthering the legitimate purposes of the above organizations in advancing the state of the art in their various lines.

"*Water Supply for Locomotives*" has an important bearing upon the economies of the motive power department. The water supply on many

roads is an unknown quantity. There are on a great many roads qualities of water furnished to locomotives which doubtless could be greatly improved at a comparatively low expenditure. There is need of systematic study to obtain from natural sources near at hand, or which can by looking into the question be made available, the best possible quality of water. In cases where a fair quality of water cannot be obtained from natural sources, the introduction of methods for purification of the water before it is introduced into the tank or boiler should be carefully considered. It is not sufficient to treat this subject in a haphazard manner, but the water supply should, if possible, be so perfected that locomotives will have as nearly as possible a uniformly good supply, in preference to a few good supply points alternating with those of poor quality, in which case the good supply may be more than nullified by the bad.

Among the means for improvement in locomotive service *"A Careful and Systematic Study of Engine Failures"* will be found productive of great good. In order for this to be the most beneficial there is necessity for complete information, and a record of each case, followed by the weekly or monthly tabulation of the cases under their appropriate headings, and a careful study of each class, and the causes producing them. Such a study will enable the weak parts or those of defective design to be quickly located, and necessary modification in design made. If bad practice exists it will be clearly shown, and the remedy can be applied.

Much is written and said in these days of *" The Relation Between the Company and its Employes,"* and a few words in this direction may not be amiss. There were times in the past perhaps when the company as represented by its officers could treat the employe as a tool or a machine. It is now recognized that the old adage of " Catching more flies with honey than with vinegar " is true in its application to the relation between the employer and employe. Railroad officers should set the example, and enforce among the shop foremen the cultivation of a feeling of friendliness and loyalty between themselves and their men. Harsh words and oaths have no place in shop discipline. When men are so hardened or careless that a reprimand or caution given in decent though forceful language will not produce the desired results, the service is better with such men out of it. Cultivate a feeling of mutual interest between the foremen and men ; let the men feel that their superior in office is not a common foe, but a friend, adviser and willing helper. Let them feel and know that they will be sure of fair, straightforward treatment, and that a promise made will be fulfilled, and half the battle of dealing with large forces of men is won. The "golden rule" applies here most admirably. It is possible for an officer to maintain proper dignity and discipline, and yet have the respect and confidence of his men. He can have a kind word and a smile for all who are deserving and still have his word known to be final and binding. *Be just, be kind, be firm.* Encourage right action and good work by a word of commendation.

During the past few years greater attention has been paid by the railroads of the country to the interests of their old and faithful employes.

It is true that when a man has served a company ten, twenty or thirty years he has accepted his wages as fair compensation for his services, but in this advanced age, in civilization, we are providing for the care and assistance of the sick, the poor, the injured, by hospitals and institutions, supported by voluntary contributions, by bequests, endowments, or by government appropriation. We are finding the Railroad Young Men's Christian Association of such value to the welfare of the employes as to warrant the giving of substantial aid by our railroads. In this same line of advanced humane action I commend to the railroad officers represented in this Association the establishing of a pension or relief system on the roads of the country. Several of the large systems of the country have such systems in successful operation, among them the Pennsylvania, Illinois Central, and Delaware, Lackawanna & Western. I would not urge the establishing of a relief system as an act of philanthropy, but as a move of immediate practical value to the railroad company in its relation to its employes. Put out the hope of some financial assistance to a man when he is too old or infirm for active service, and he will think carefully before leaving a service where he has acquired certain rights or privileges for the future, which would all be lost by a change of service, or by an unwise or antagonistic action. It is to be hoped in the interest of a decided advance in the standard of relationship of employer and employe that the railroad companies of America will quite generally establish a systematic relief or pension system on their lines in the near future.

If I may make suggestions as to lines of future usefulness of the Association, I would say that with its present standing as a progressive body of railroad men we might profitably inaugurate tests and experiments affecting locomotive performance, looking to a better understanding of the possibilities of obtaining "reserve power," which is so greatly needed; experiments on various lengths of boiler tubes; the relative values of various kinds of heating surfaces; the possibilities of ribbed or corrugated boiler tubes, of the Serve or Whitney types. These and many other lines of investigation and experiment would, though costing considerable money, add much to the permanent value of the Association's work.

I would recommend that a committee be appointed to revise and retabulate the Standards, Recommended Practices and Standing Resolutions of the Association, many of which are not now up to date.

I would also recommend the establishing of a standing committee to report to the Association from year to year on the "Progress of the Year." Data of this kind have in the past been taken up in a cursory manner by the President in his address, but in the hands of a standing committee the progress in railroad mechanical matters could be made of greater value, and more complete, than the limited reference only that can be allotted to the subject in the opening address. Such a committee could discuss the improvements in locomotives, shop practice, new machine tools, new tool steel, not in any way to advertise manufactures, but to bring new principles and methods before the Association for discussion.

I would suggest the further development of the idea of "individual papers" as a means of getting at important subjects. The "Committee Report" suggests at once a record of experience that brings up a discussion of the past, which is indeed valuable. We need, however, to look oftener into the future, and an individual who has been giving time and thought to certain lines of investigation can do this better than a committee. A committee always must present modified opinions—modified to suit the committee views. A number of subjects must always be handled by committees, but a goodly proportion of subjects can better be presented by an individual, because the opinions are not "trimmed" to suit any member of the committee who may possibly be extremely conservative.

In the individual papers presented before this convention the members will see that a great deal of painstaking work has been done. One advantage of the individual paper is to give credit to the one who has done the hard work, which is not always true of committee reports.

A further suggestion is that we avail ourselves more in the future than in the past of the valuable knowledge and assistance of our Associate Members in connection with committee work. It will be noticed that this year the Executive Committee selected one Associate Member for each committee.

The work of the various railroad clubs is rapidly taking on a higher character and value, and it behooves the Master Mechanics' Association to look out for itself, or these clubs will soon be doing its most important work. It should be our aim and endeavor to place our meetings above the mere "experience meeting" plane, and get into work which is fully in keeping with the national character of our organization. We should study the real problems of motive power, and discuss progress, with a view of making our department fill its important place, so that it will be recognized because of its real grasp of its business problems. Not that this has not been done to a large extent in the past, but there is room for filling a much larger and more important field in our future work.

The committee reports and papers to be presented at this meeting are on subjects of vital interest. They have been so ably handled, and are likely to be productive of so lively and profitable discussion, that special individual mention and comment need not be made at this time.

The reports of the Secretary and Treasurer show the continued prosperous condition of this Association.

We have a total membership of 712, an increase of five per cent. over last year, and of over 1,700 per cent. since 1868.

Our financial condition is of the best, with a fund above all indebtedness of $2,700.89.

The scholarships in the Stevens Institute of Technology are all filled, and there are applicants still in waiting for the first vacancy.

Death has entered our ranks, and we to-day mourn the loss of three active members, Angus Brown, W. L. Hoffecker, and J. H. Buckalow, one associate member, Jerome Wheelock, and one honorary member, J. H.

Leeds. Appropriate memorials will be prepared for our Proceedings by committees which will be named later in the session.

Appreciation of the value of the mechanically trained man in the higher official positions of the operating departments of our railroads has been shown the past year by the selection and advancement to high positions of several of our members, including our first and second Vice-Presidents. There are no departments in the railroad service which develop men in a broader manner to occupy high executive positions in the management of our railways than the mechanical department, coming in contact as it does with more or less of the detail and troubles of every branch of the service. The numerous selections from this department during the past few years for General Superintendents, General Managers and Vice-Presidents should be an incentive for bringing out the best and broadest work possible in the development of American railways by the members of this Association.

In conclusion I desire to congratulate the Association upon its prosperous condition, and I wish to thank the elective officers and our able and energetic Secretary for their hearty co-operation during the past year, and I bespeak your active participation and support in the work of the convention of 1902, which is now before us.

The convention then took an intermission of five minutes.

The following members were present at this and subsequent sessions:

W. C. Arp.	G. A. Coolidge.	John Foulk.
G. S. Allen.	C. H. Cory.	F. F. Gaines.
W. E. Amann.	F. J. Cole.	W. Garstang.
A. O. Berry.	J. J. Connolly.	H. D. Gordon.
R. C. Blackall.	C. W. Cross.	C. Graham.
T. R. Browne.	W. D. Crossman.	W. L. Gilmore.
A. Buchanan, Jr.	M. S. Curley.	W. F. M. Goss.
H. S. Bryan.	W. C. Dallas.	R. J. Gross.
Paul H. Brangs.	M. R. Davis.	J. A. Gibson.
G. M. Basford.	E. E. Davis.	A. Gardner.
F. W. Brazier.	J. F. Deems.	F. H. Givin.
G. E. Branch.	C. A. Delaney.	L. B. Heers.
E. C. Bates.	H. Delaney.	D. Hawksworth.
David Brown.	George Donahue.	G. H. Haselton.
F. H. Clark.	S. M. Dolan.	G. A. Hancock.
L. T. Canfield.	R. L. Ettinger.	B. Haskell.
J. A. Carney.	T. M. Feeley.	J. A. Hill.
A. J. Cota.	James Fitzmorris.	W. L. Holman.
G. W. Cushing.	M. N. Forney.	D. Holtz.
J. Christopher.	G. L. Fowler.	H. Wade Hibbard.
J. S. Chambers.	Thomas Fildes.	C. D. Hilferty.
F. A. Chase.	G. A. Ferguson.	Frank Hedley.

John Howard.	J. G. Neuffer.	W. T. Smith.
O. H. Jackson.	L. C. Noble.	J. R. Slack.
J. E. Keegan.	James Ogilvie.	W. Smith.
S. L. Kneass.	M. B. Parker.	F. C. Smith.
J. L. Lawrence.	L. G. Parish.	H. Swoyer.
W. H. Lewis.	J. O. Pattee.	C. A. Seley.
F. W. Lane.	John Player.	Charles J. Thornton.
W. W. Lowell.	Peter H. Peck.	W. O. Thompson.
T. A. Lawes.	S. F. Prince, Jr.	W. T. Thomas.
J. H. McConnell.	L. R. Pomeroy.	W. H. Thomas.
J. P. McCuen.	E. W. Pratt.	John Tonge.
William McIntosh.	T. B. Purves, Jr.	W. T. Thompson.
John MacKenzie.	C. H. Quereau.	J. S. Turner.
W. J. McLean.	G. N. Riley.	L. C. Todd.
J. W. Marden.	O. H. Reynolds.	David Van Alstine.
C. J. McMasters.	F. Robinson.	H. H. Vaughan.
E. S. Marshall.	C. B. Royal.	G. W. West.
B. F. Marshall.	C. E. Rettew.	A. M. Waitt.
G. S. McKee.	W. D. Robb.	F. M. Whyte.
E. A. Miller.	G. W. Seidell.	A. M. White.
G. A. Miller.	D. A. Smith.	F. O. Walsh.
H. C. Manchester.	T. H. Symington.	D. A. Wightman.
J. W. Marden.	E. T. Sumner.	R. V. Wright.
S. W. Miller.	Angus Sinclair.	A. H. Watts.
C. J. Mellin.	R. D. Smith.	E. A. Williams.
John Medway.	O. Stewart.	G. Wirt.
E. P. Mallinson.	L. A. Shepard.	G. W. Wildin.
P. H. Minshull.	T. A. Summerskill.	C. B. Young.

THE PRESIDENT: The first business after the intermission is your action upon the minutes of the previous meeting, which have been printed and are in your hands; and unless errors or corrections are to be noted in the minutes, unless there is a motion otherwise, they will stand as approved. Hearing nothing to the contrary they stand approved.

MR. ANGUS SINCLAIR: I wish to offer a resolution that seems to precede all others, considering that it is in connection with the President's opening address. It is that a committee be appointed to arrange for carrying out the recommendations made in the President's address. In offering this resolution, I wish to say that year after year we hear very valuable addresses, with recommendations made which are of the greatest importance to the Association. The President generally studies all the progress made during the year and presents his views upon it in recom-

mendations in his address, yet these addresses have been passed year after year and nothing done with them, for the simple reason that it was not the business of any one to attend to the recommendations made. Very valuable addresses from our presidents have had less influence on the progress of the Association than the most minor reports that we have had presented. Therefore, I think it is a very good plan to follow out the recommendations of the President in having a standing committee to deal with that matter, but in the meantime I think it is very desirable that this committee should be appointed at this particular time.

The motion was carried.

THE PRESIDENT: How will the committee be appointed? I would suggest that it would be embarrassing for the President to appoint such a committee, and that the matter be left for our Vice-President, Mr. West, to appoint such a committee.

PROF. GOSS: I move that be the order—that the Vice-President appoint the committee.

The motion was carried.

THE PRESIDENT: Mr. West will announce the committee later in the session.

The next order of business is the report of the Secretary.

Secretary Taylor presented the following report:

To the President and Executive Committee of the American Railway Master Mechanics' Association:

A resume of the growth and financial condition of the Association during the past year is given below:—

MEMBERSHIP.

ACTIVE MEMBERS.

Membership June, 1901		637
Transferred to Honorary Membership	12	
Resigned	15	
Deaths	3	
		30
		607

New members		49	
Reinstated		2	
			51
			658

ASSOCIATE MEMBERS.

Associate Members		19	
Added during year		2	
		21	
Deaths	1		
Transferred	1		
		2	
			19
Honorary Membership		24	
Transferred from Active		12	
		36	
Deaths		1	
			35
Total Membership			712

The names of members transferred to the honorary membership are as follows: Messrs. J. M. Boon, Allen Cooke, W. A. Foster, John Hewitt, W. H. Lewis, L. B. Paxson, J. H. Setchel, D. O. Shaver, J. M. Sheer, H. N. Sprague, Wm. Swanston and Reuben Wells.

The resignations are: Messrs. A. E. Benson, Isaac Bond, J. L. Brown, M. T. Carson, J. M. Coale, Wm. Cockfield, A. B. Cook, F. W. Johnstone, A. V. Macdonald, Robert Miller, G. L. Potter, M. J. Redding, M. M. Reid, F. H. Stevens, and J. W. Sanford.

The deaths are: Messrs. Angus Brown, active; J. H. Buckalew, active; W. L. Hoffecker, active; Jerome Wheelock, associate, and J. H. Leeds, honorary members.

The new members received during the year are:

H. L. Aldana, S. M. P., Central Northern Ry., Tucuman, Arg. Rep., S. A.
A. O. Berry, M. E., Boston & Albany R. R., Boston, Mass.
John Birse, M. M., Chicago Great Western Ry., Des Moines, Iowa.
R. P. Blake, M. E., Northern Pacific Ry., St. Paul, Minn.
C. F. Chase, M. M., Manchester Locomotive Works, Manchester, N. H.
C. T. Cooper, G. F., T. & O. C. Ry., Kenton, Ohio.
S. B. Clay, Dist. Foreman, Ft. Worth & Denver City Ry., Clarendon, Texas.
J. W. Cross, Asst. Works Mgr., Great Western Ry., Swindon, England.
G. A. Emerson, G. M. M., Great Northern Ry., Spokane, Wash.
J. W. Fogg, M. M., Chicago Terminal Transfer Ry., East Chicago, Ind.

S. F. Forbes, Asst. S. M. P., Central R. R. of New Jersey, Jersey City, N. J.
Thomas Fildes, Asst. S. M. P., Long Island R. R., Richmond Hill, N. Y.
P. M. Hammett, S. M. P., Maine Central R. R., Portland, Maine.
F. N. Hibbitts, M. E., Union Pacific R. R., Omaha, Neb.
P. J. Hickey, M. M., C. C. C. & St. L. Ry., Mattoon, Ill.
F. F. Hildreth, M. M., Terre Haute & Indianapolis Ry., Terre Haute, Ind.
C. D. Hilferty, G. F., Michigan Central R. R., Jackson, Mich.
C. H. Hogan, M. M., N. Y. C. & H. R. R. R., East Buffalo, N. Y.
Ben Johnson, S. M. P., Mexican Central R. R., Mexico City, Mexico.
Wm. Jenkins, F. M. D., So. Carolina & Ga. Ext. R. R., Blacksburg, S. C.
C. B. Hutchinson, M. M., Boston & Maine R. R., Lyndonville, Vt.
J. I. Krause, M. M., Louisiana & North-West R. R., Gibsland, La.
John Lahey, D. M. M., K. C. Southern Ry., Shreveport, La.
H. M. Meaney, D. M. M., Gulf & Ship Island Ry., Gulfport, Miss.
W. R. McKeen, Jr., M. M., Union Pacific R. R., Cheyenne, Wyo.
W. J. McLeish, S. M. P. & R. S., Evansville & Terre Haute R. R., Evansville, Ind.
C. M. Muchnic, M. E., Wisconsin Central Ry., Fond du Lac, Wis.
John Neville, Div. Foreman, Denver & Ft. Worth Ry., Clarendon, Texas.
C. R. Ord, M. M., Canadian Pacific Ry., McAdam Junction, N. B., Can.
L. G. Parish, M. C. B., Lake Shore & Michigan Southern Ry., Englewood, Ill.
S. T. Park, D. M. M., Santa Fe Pacific Ry., Winslow, Ariz.
J. H. Pengelly, D. M. M., Mexican International Ry., Durango, Mexico.
F. E. Place, M. M., Illinois Central R. R., Chicago, Ill.
Eli Punshon, Div. Foreman, K. C. Southern Ry., Pittsburg, Kan.
D. J. Redding, M. M., Pittsburg & Lake Erie R. R., McKees Rocks, Pa.
Jos. Roberts, M. M., Union Pacific R. R., Kansas City, Kas.
W. D. Robb, S. M. P., Grand Trunk Railway, Montreal, Can.
C. T. Rommell, M. M., Lehigh & New England R. R., Pen Argyl, Pa.
C. H. Seabrook, G. F., St. Louis Southwestern Ry., Pine Bluff, Ark.
J. J. Sullivan, M. M., Louisville & Nashville R. R., Louisville, Ky.
H. Swoyer, M. M., G. M. M., Louisville & Nashville R. R., Louisville, Ky.
A. E. Tabor, M. M., Montana Central Ry., Great Falls, Mont.
W. O. Thompson, Gen. Loco. Insp., N. Y. C. & H. R. R. R., W. Albany, N. Y.
Max Toltz, M. E., Great Northern Ry., St. Paul, Minn.
W. C. Walsh, M. M., Southern Indiana Ry., Bedford, Ind.
W. White, M. M., Lake Erie & Western Ry., Lima, Ohio.
G. W. Wildin, M. E., Central R. R. of New Jersey, Jersey City, N. J.
R. V. Wright, M. E., Pittsburgh & Lake Erie R. R., Pittsburg, Pa.

The reinstatements are:

G. H. Haselton, D. S. M. P., N. Y. C. & H. R. R. R., Depew, N. Y.
T. A. Summerskill, S. M. P., Central Vermont R. R., St. Albans, Vt.

The receipts and expenses for the year ending June 9, the date of closing the books preparatory to this report, are as follows:

RECEIPTS.

To Sums Collected from Members	$3,125.00
" Sale of Proceedings	1,076.78
" Sale of Index	144.96
" Interest on Bank Balances	1.53
Total	$4,348.27

EXPENSES.

Paid Reporting Convention, 1901	279.00
" Expenses Convention, 1901	61.70
" Printing	1,755 41
" Electros, Zincs, etc.	202.57
" Stamps and Stamped Envelopes	265.73
" Exchange	15.80
" Office Supplies	10.23
" Office Rent	171.36
" Telegrams	1.90
" Expressage	11.62
" Tracings, Blue Prints, etc.	81.00
" Surety Bonds, Secretary and Treasurer.	21.80
" Expenses Committees	33.50
" Salary Secretary, June 30, 1901, to June 20, 1902, including clerk	1,200.00
" Balance Remitted to Treasurer	236.65
Total	$4.348.27

There are no unpaid bills against the Association, and the money belonging to the Association is in the hands of the Treasurer.

The unpaid dues amount to $890.00. A detailed statement of the members in arrears is attached hereto for the information of members.

A detailed statement of dues collected from members during the year is attached hereto as a part of the report.

SCHOLARSHIPS.

The four scholarships of the Association at the Stevens' Institute of Technology, Hoboken, N. J., have been filled, but owing to one of the scholars graduating, there will be one vacancy at the spring term. I hope to be able to advise the members before the convention adjourns that it has been filled, as the examinations are being held this week, and the Secretary has certified to several applicants being eligible.

It might be well to add for the information of the members that under these scholarships the privilege is conferred of attending the entire course of the institute for four years, free of all charge for tuition, provided, of course, the student holding the scholarship keeps up in all cases with the standard of proficiency and good conduct required.

DETAILS OF DUES COLLECTED FROM MEMBERS.

June	13	C. B. Royal....	$5.00
"	13	Wm. Smith....	5.00
"	13	A. Sauter......	5.00
"	13	Thos. Paxton..	5.00
"	13	C. A. Thompson	10.00
"	13	John Howard ..	5.00
"	13	Z. T. Sprigg...	10.00
"	13	H. T. Bruck....	10.00
"	14	L. C. Todd.....	5.00
"	20	G. S. Allen....	5.00
"	20	W. C. Arp......	5.00
"	20	R. C. Blackall..	5.00
"	20	G. E. Branch...	5.00
"	20	David Brown ..	5.00
"	20	J. S. Chambers.	5.00
"	20	F. H. Clark....	5.00
"	20	J. G. Clifford...	5.00
"	20	J. J. Connolly...	5.00
"	20	D. C. Courtney.	5.00
"	20	W. Cross.......	5.00
"	20	D. Delaney	15.00
"	20	M. J. Drury	5.00
"	20	J. J. Ewing....	5.00
"	20	Thos. Fildes....	5.00
"	20	A. Forsyth.....	5.00
"	20	W. Garstang....	5.00
"	20	T. W. Gentry...	5.00
"	20	H. D. Gordon..	5.00
"	20	J. A. Graham...	5.00
"	20	Rufus Hill......	5.00
"	20	W. W. Hodgkins	5.00
"	20	David Holtz....	5.00
"	20	F. T. Hyndman..	5.00
"	20	W. E. Killen....	5.00
"	20	L. L. Lawrence.	5.00
"	20	P. Leeds..........	5.00
"	20	E. P. Mallinson.	5.00
"	20	Wm. McIntosh.	5.00
"	20	C. J. Mellin.....	5.00
"	20	E. A. Miller...	5.00
		Carried forward ...	$225.00

Brought		*forward*	$225.00
June	20	G. W. Miller...	15.00
"	20	J. J. Monahan..	5.00
"	20	O. H. Reynolds.	5.00
"	20	G. W. Rhodes..	5.00
"	20	Mason Rickert..	5.00
"	20	J. J. Ryan......	5.00
"	20	Hugo Schaefer.	10.00
"	20	F. C. Smith...	15.00
"	20	W. T. Smith...	5.00
"	20	A. F. Stewart...	5.00
"	20	O. Stewart	5.00
"	20	E. T. Sumner..	15.00
"	20	R. D. Sutherland	10.00
"	20	John Taylor....	5.00
"	20	W. T. Thompson	5.00
"	20	John Tonge....	5.00
"	20	S. R. Tuggle....	5.00
"	20	B. Warren.....	5.00
"	20	W. B. Warren..	5.00
"	20	Geo. W. West..	5.00
"	20	G. Wirt........	5.00
"	20	F. J. Zerbee....	5.00
"	20	E. Chamberlin..	10.00
"	20	W. White......	5.00
"	20	C. H. Hogan...	5.00
"	20	P. J. Hickey...	5.00
"	20	S. F. Forbes....	5.00
"	20	C. F. Chase....	5.00
"	20	F. F. Hildreth..	5.00
"	20	J. J. Sullivan..	5.00
"	20	W. J. McLeish.	5.00
"	20	C. W. Lee......	5.00
"	20	Geo. James.....	5.00
"	20	H. M. Meaney..	5.00
"	20	Angus Brown..	5.00
"	20	G. H. Haselton.	15.00
"	20	O. H. Jackson..	5.00
"	20	C. H. Quereau..	5.00
"	29	A. Moraga......	10.00
		Carried forward ...	$480.00

Brought	*forward*		$480.00
June	29	R. F. Kilpatrick	5.00
"	29	C. F. Lape......	5.00
"	29	W. M. Kummer	5.00
"	29	S. Susuki.......	5.00
July	3	G. W. Cushing..	5.00
"	6	W. L. Gilmore..	5.00
"	6	J. P. Nolan....	5.00
"	9	C. A. Delaney..	5.00
"	9	G. R. Henderson	5.00
"	9	J. C. Shields...	5.00
"	9	W. H. V. Rosing	5.00
"	9	F. W. Dean....	5.00
"	9	S. Higgins	5.00
"	9	J. E. Gould.....	5.00
"	9	J. B. Barnes....	5.00
"	9	C. H. Howard.	5.00
"	9	H. F. Ball......	5.00
"	9	J. G. Neuffer...	5.00
"	9	A. G. Leonard..	5.00
"	9	G. L. Dickson..	5.00
"	9	J. L. Brown....	5.00
"	9	C. H. Welch...	5.00
"	9	I. N. Wilbur...	5.00
"	9	H. H. Vaughan.	5.00
"	9	Alfred Lovell...	5.00
"	9	J. E. Keegan....	5.00
"	9	J. B. Morgan..	5.00
"	9	E. M. Herr....	5.00
"	9	J. Hainen......	5.00
"	9	E. S. Marshall..	5.00
"	12	J. M. Wallis...	5.00
"	12	J. R. Slack....	5.00
"	12	P. H. Peck.....	5.00
"	12	Thos. Millen...	5.00
"	12	Wm. O'Herin..	5.00
"	12	C. E. Fuller....	5.00
"	12	C. E. Rettew...	5.00
"	12	W. H. Wilson..	5.00
"	12	W. L. Austin..	5.00
"	12	A. B. Johnson..	5.00
"	12	J. Wheelock....	5.00
"	12	J. R. Groves....	5.00
"	12	A. M. Waitt....	5.00
		Carried forward ...	$695.00

Brought	*forward*		$695.00
July	12	S. L. Kneass...	5.00
"	12	Amos Turner...	5.00
"	12	Philip Wallis...	5.00
"	12	C. D. Hilferty..	5.00
"	12	F. C. Cleaver..	5.00
"	12	W. F. M. Goss..	5.00
"	12	S. F. Prince, Jr.	5.00
"	12	J. S. Turner....	5.00
"	12	E. L. Weisgerber	5.00
"	12	W. P. Appleyard	5.00
"	12	M. S. Curley...	5.00
"	12	R. H. Soule....	5.00
"	12	T. A. Lawes....	5.00
"	12	R. Moran......	5.00
"	12	Jas. Ashworth..	5.00
"	12	A. B. Minton...	5.00
"	12	W. H. Thomas.	5.00
"	12	D. S. Cooper..	5.00
"	12	Chas. H. Barnes	5.00
"	12	W. H. Taylor..	5.00
"	12	T. S. Lloyd....	5.00
"	12	J. Potton	10.00
"	15	F. M. Whyte...	5.00
"	15	A. H. Watts ...	10.00
"	15	W. H. Nuttall..	5.00
"	15	H. M. Pflager..	5.00
"	15	Chas. H. Davis.	5.00
"	15	C. H. Wiggin..	5.00
"	15	H. J. Small....	5.00
"	15	A. G. Machesney	5.00
"	15	Alf. Williams...	10.00
"	15	W. B. Gaskins..	5.00
"	15	T. H. Tyrrell..	5.00
"	15	P. H. Murphy..	5.00
"	18	J J Casey ..	5.00
"	18	Angus Sinclair .	5.00
"	18	W Sinnott .	5.00
"	18	John Medway..	5.00
"	18	R. O. Cumback.	5.00
"	18	C. E. Slayton..	5.00
"	18	F. W. Mahl....	10.00
"	18	A. J. Pitkin....	5.00
		Carried forward ...	$925.00

Brought forward		....	$925.00
July	18	J. A. Hansgen.	10.00
"	18	C. F. Baker....	5.00
"	18	F. A. Delano..	5.00
"	18	F. W. Morse...	5.00
"	18	L. S. Randolph.	5.00
"	18	R. J. Gross....	5.00
"	18	J. C. Glass.....	5.00
"	18	B. Haskell......	5.00
"	18	F. F. Tynan....	5.00
"	18	L. A. Shepard .	5.00
"	24	S. T. Balkam..	5.00
"	24	Jas. Macbeth...	5.00
"	24	M. Bartlett.....	5.00
"	24	D. Hawksworth	5.00
"	24	C. P. Weiss....	5.00
"	24	C. E. Keyworth.	5.00
"	24	A. W. Belcher..	5.00
"	24	J. W. Addis....	5.00
"	24	F. E. Davisson.	5.00
"	24	Willard Kells...	5.00
"	24	John Hair......	5.00
"	24	Jas. A. Egan....	5.00
"	24	F. A. Chase....	5.00
"	24	A. J. Dunn.....	5.00
"	24	G. R. Joughins..	5.00
"	24	E. Ryan........	5.00
"	24	J. A. Carney...	5.00
"	24	F. J. Cole......	5.00
"	24	P. P. Foller....	5.00
"	24	G. E. Van Brunt	5.00
"	24	J. L. Greatsinger	5.00
"	24	W. H. Marshall.	5.00
"	24	J. R. Bissett....	5.00
"	24	L. R. Pomeroy..	5.00
"	24	J. J. Ellis......	5.00
"	24	F. Mertscheimer.	5.00
"	24	C. A. Seley....	5.00
"	24	W. L. Hoffecker	5.00
"	24	J. H. McConnell	5.00
"	29	J. A. Hill......	5.00
"	29	W. J. Thomas..	5.00
"	29	Henry Schlacks.	5.00
"	29	W. Laing.......	5.00
Carried forward		...	$1,145.00

Brought forward		......	$1,145.00
July	29	Geo. C. Morton	5.00
"	29	F. H. Neward..	10.00
"	29	W. S. Hancock.	5.00
"	29	A. Beckert......	5.00
"	29	S. M. Vauclain.	5.00
"	29	A. E. Mitchell..	5.00
"	29	A. E. Manchester	5.00
"	29	T. E. Adams...	5.00
"	29	W. H. Lewis...	5.00
"	29	D. O'Leary.....	5.00
"	29	E. C. Bates....	5.00
"	29	Amos Pilsbury.	5.00
"	29	W. S. Morris..	5.00
"	29	T. M. Feeley...	5.00
"	29	J. W. Cloud....	5.00
"	29	J. F. Dunn.....	5.00
"	30	S. T. Park.....	5.00
"	30	T. W. Place....	5.00
"	30	C. K. Bowles...	5.00
Aug.	1.	Wm. Renshaw.	5.00
"	1	C. R. Yohn....	5.00
"	1	W. K. Christie..	5.00
"	1	D. J. Justice...	5.00
"	3	Owen Clarke ..	5.00
"	3	C. M. Mendenhall	5.00
"	3	John Player ...	5.00
"	3	P. H. Minshull.	5.00
"	3	Jas. W. Hill....	5.00
"	3	John Gill	5.00
"	3	J. J. Tomlinson.	5.00
"	3	C. R. Ord......	5.00
"	3	G. A. Hancock.	5.00
"	3	John Neville ..	5.00
"	3	T. M. Gibb....	5.00
"	3	A. L. Humphrey	5.00
"	3	Geo. D. Brooke.	5.00
"	7	Jas. K. Brassell.	5.00
"	7	J. A. Hanglin..	5.00
"	7	F. J. Leigh.....	5.00
"	7	Wm. Fuller....	5.00
"	7	Robert Quayle..	5.00
"	7	F. T. Slayton...	5.00
Carried forward		...	$1,360.00

Brought forward		....	$1,360.00
Aug.	7	W. H. Taft...	5.00
"	7	C. Phillips......	5.00
"	7	J. R. Van Cleve.	5.00
"	7	G. N. Riley....	5.00
"	7	L. H. Turner...	5.00
"	7	J. E. Sague.....	5.00
"	7	I. W. Fowle...	5.00
"	7	E. D. Bronner..	5.00
"	7	B. F. Marshall..	5.00
"	7	L. T. Canfield..	5.00
"	8	W. J. McLein.	5.00
"	8	Tracy Lyon ...	5.00
"	8	Geo. F. Wilson.	5.00
"	8	L. B. Rhodes..	5.00
"	8	C. J. McMasters	5.00
"	8	G. W. Kenney..	5.00
"	8	T. M. Malone..	10.00
"	8	F. W. Johnstone	5.00
"	8	E. A. Williams.	5.00
"	8	B. H. Hawkins.	5.00
"	8	Allen Vail......	5.00
"	8	John Birse.....	5.00
"	19	Henry Elliott...	5.00
"	19	H. L. Leach....	5.00
"	19	J. D. Campbell.	5.00
"	19	F. D. Casanave.	5.00
"	19	A. S. Vogt.....	5.00
"	19	A. W. Gibbs...	5.00
"	19	W. W. Atterbury	5.00
"	19	W. N. Best....	5.00
"	19	W. S. Templeton	5.00
"	19	T. W. Demarest	5.00
"	19	F. J. Smith....	5.00
"	19	J. Cullinan.....	5.00
"	19	R. D. Smith...	5.00
"	19	J. Horrigan....	5.00
"	19	L. C. Noble....	5.00
"	19	W. J. Tollerton.	5.00
"	19	W. E. Symons..	5.00
"	19	J. E. Irwin....	5.00
Carried forward...			$1,565.00

Brought forward		......	$1,565.00
Aug.	19	Geo. Curry	5.00
"	19	D. F. Crawford.	5.00
"	20	W. H. Traver..	5.00
"	23	E. S. Walker..	5.00
"	23	R. V. Wright...	5.00
"	26	Wm. Forsyth...	5.00
"	26	Jos. Townsend..	5.00
"	26	L. M. Butler...	5.00
"	30	F. Hufsmith....	5.00
"	30	J. O. Bradeen..	10.00
"	30	V. B. Lang.....	5.00
"	30	Jos. Roberts....	5.00
Sept.	2	C. T. Cooper...	5.00
"	2	Geo. H. Baker..	5.00
"	2	C. J. Cooper....	5.00
"	2	H. S. Bryan....	5.00
"	4	J. B. Michael...	5.00
"	4	Wilbur Green..	5.00
"	4	W. Augustus ...	5.00
"	6	C. S. Morse....	5.00
"	6	S. P. Bush.....	5.00
"	9	T. W. Heintzleman	5.00
"	9	A. Villasenor...	5.00
"	9	H. A. Childs...	5.00
"	11	P. Maher.......	5.00
"	12	D. A. Wightman	5.00
"	12	E. T. James....	5.00
"	20	W. A. Brown..	5.00
"	20	C. E. Turner...	5.00
"	20	C. E. Nuttall...	5.00
"	20	E. N. Weist....	5.00
"	21	H. T. Thomas.	5.00
"	21	John S. Cook...	5.00
"	21	Jas. McNaughton	5.00
"	21	P. E. Garrison..	5.00
"	24	F. B. Griffith...	15.00
"	24	Thos. Roope....	5.00
"	24	H. T. Bentley..	5.00
"	24	Jas. Strode.....	5.00
"	24	J. W. Connatty.	5.00
"	24	W. J. Hemphill.	10.00
Carried forward...			$1,790.00

Brought forward			$1,790.00
Sept.	24	Jas. Cunningham	5.00
"	27	R. A. Smart...	5.00
"	30	T. S. Beauclerk.	5.00
"	30	A. V. Macdonald	5.00
Oct.	4	G. S. Mackinnon	5.00
"	4	J. H. Vought.	5.00
"	4	W. D. Robb...	5.00
"	4	H. S. Hayward.	5.00
"	4	Max Toltz......	5.00
"	4	J. N. Sanborn.	10.00
"	5	S. B. Clay......	5.00
"	9	H. C. Smith....	5.00
"	9	Geo. Gibbs.....	5.00
"	12	H. Tregelles....	5.00
"	12	John Mackenzie	5.00
"	16	A. L. Studer...	5.00
"	18	H. D. Ellis.....	5.00
"	18	T. W. Gentry..	5.00
"	26	L. Greaven.....	5.00
"	26	J. J. Thomas, Jr.	10.00
"	26	G. W. Wildin..	5.00
"	26	E. E. Davis....	5.00
"	26	D. Van Alstine.	5.00
"	26	G. H. Emerson.	5.00
"	26	J. H. Manning..	5.00
"	26	H. M. C. Skinner	5.00
"	26	C. M. Babcock..	5.00
"	31	G. M. Basford..	5.00
"	31	Jos. R. Spragge.	5.00
"	31	S. M. Dolan....	5.00
Nov.	11.	A. M. White...	5.00
"	11	Thos. Jennings.	5.00
"	22	A. S. Erskine..	10.00
"	22	J. H. Pengelly..	5.00
"	22	C. E. Stevenson	5.00
Dec.	5.	P. D. Plank...	5.00
"	5	F. W. Lane....	5.00
"	13	J. M. Davies...	5.00
"	13	L. H. Spillard..	5.00
"	13	A. W. Trombly.	5.00
"	17	R. J. Callander.	15.00
"	19	J. W. Fogg.....	5.00
		Carried forward...	$2,025.00

Brought forward			$2,025.00
Dec.	19	G. A. Fergusson	5.00
"	19	C. M. Muchnic..	5.00
"	23	R. J. Callander.	5.00
"	23	T. Rumney.....	5.00
"	23	F. Colin York..	10.00
Jan.	6	A. J. Cromwell.	5.00
"	6	Jas. Hardie.....	5.00
"	6	R. F. Hoffman.	5.00
"	13	R. P. Blake....	5.00
"	13	G. L. Fowler...	5.00
"	13	W. A. Smith...	5.00
"	13	G. W. Stevens..	5.00
"	13	S. K. Dickerson	5.00
"	13	F. B. Smith....	5.00
"	13	W. H. Brehm..	5.00
"	13	G. T. Neubert..	5.00
"	13	J. S. Patterson.	5.00
"	13	A. T. West.....	5.00
"	13	R. M. Galbraith.	5.00
"	13	F. F. Gaines....	5.00
"	13	W. A. Nettleton.	5.00
"	13	T. A. Foque...	5.00
"	13	J. W. Marden.	10.00
"	13	C. M. Seabrook.	5.00
"	15	L. G. Parish...	5.00
"	15	F. Singer.......	5.00
"	15	D. J. Redding..	5.00
"	15	F. N. Hibbitts..	5.00
"	15	A. C. Hone....	5.00
"	15	M. J. Rogers..	5.00
"	15	H. Wade Hibbard	5.00
"	15	J. H. Pennington	5.00
"	15	W. L. Tracy....	5.00
"	15	G. S. McKee....	10.00
"	15	Alex. Laird....	5.00
"	17	H. A. Gillis...	5.00
"	17	P. T. Lonergan.	5.00
"	17	R. H. Briggs...	5.00
"	17	S. J. Dillon.....	5.00
"	17	W. D. Crosman.	5.00
"	17	Geo. A Bruce..	5.00
"	17	Oscar Antz.....	5.00
		Carried forward...	$2,250.00

Brought forward		......	$2,250.00
Jan.	17	F. O. Walsh...	5.00
"	17	W. H. Stocks..	5.00
"	17	S. L. Bean.....	5.00
"	17	H. O. Westmark	5.00
"	20	John Player....	5.00
"	20	J. E. Muhlfield.	10.00
"	29	C. M. Taylor..	5.00
"	20	A. McCormick..	5.00
"	20	G. A. Gallagher.	5.00
"	23	F. J. Harrison.	10.00
"	23	E. A. Walton..	5.00
"	23	J. P. McCuen...	5.00
"	23	F. N. Risteen...	5.00
"	23	C. A. Prescott..	5.00
"	23	F. L. Bates....	5.00
"	23	Thos. Walsh....	5.00
"	23	T. McNabb.....	5.00
"	23	W. F. Post.....	5.00
"	23	J. H. Buckalew.	5.00
"	23	J. Christopher..	5.00
"	23	H. M. Minto...	5.00
"	23	Wm. Cockfield..	5.00
"	23	T. M. Conlon..	5.00
Feb.	3	W. R. McKeen, Jr.	5.00
"	3	Wm. Thow.....	5.00
"	3	A. E. Tabor....	5.00
"	3	R. W. Bushnell.	5.00
"	3	L. I. Knapp....	5.00
"	3	M. R. Davis....	5.00
"	7	F. Hedley......	5.00
"	7	C. Skinner.....	5.00
"	7	W. J. Wilcox...	5.00
"	7	Jas. McDonough	5.00
"	7	F. M. Twombly.	5.00
"	7	H. G. Bechhold.	5.00
"	12	C. T. Rommell..	5.00
"	12	I. Bond........	5.00
"	12	John O'Brien...	5.00
"	12	W. C. Squire..	5.00
"	12	F. E. Place....	5.00
"	15	Chas DeGress..	5.00
"	15	H. Stillman.....	5.00
Carried forward		...	$2,470.00

Brought forward		......	$2,470.00
Feb.	17	Wm. Jennings.	10.00
"	18	Jas. Fitzmorris.	5.00
"	20	W. P. Orland.	5.00
"	24	E. Barrington..	5.00
"	24	Wm. Hassman..	5.00
Mar.	3.	I. N. Kalbaugh.	10.00
"	3	J. A. Quinn....	5.00
"	10	John Hopwood.	5.00
"	10	Frank Slater...	5.00
"	10	G. W. Seidell..	5.00
"	12	Z. T. Brantner..	10.00
"	12	N. W. Sample..	5.00
"	12	W. L. Holman..	5.00
"	12	R. Tawse.......	5.00
"	12	R. L. Ettinger..	5.00
"	12	C. H. Cory....	5.00
"	13	H. Tandy......	5.00
"	13	J. B. Johnson...	5.00
"	13	C. T. McElvaney	5.00
"	14	L. B. Heers....	5.00
"	17	G. W. Butcher..	5.00
"	17	Jas. Collinson...	5.00
"	17	M. K. Barnum..	5.00
"	17	L. R. Johnson..	5.00
"	17	J. A. Edwards..	5.00
"	17	R. P. C. Sanderson	5.00
"	17	P. H. Brangs..	5.00
"	17	R. Gould.......	5.00
"	19	T. R. Browne...	5.00
"	19	W. C. Dallas...	5.00
"	19	J. Billingham...	5.00
"	19	Thos. Paxton...	5.00
"	19	W. C. Ennis....	5.00
"	22	C. F. Thomas..	5.00
"	22	Peter C. Rusch.	5.00
"	26	Harry Pearse...	5.00
"	26	J. C. Haggett...	5.00
"	31	F. W. Webb....	5.00
"	31	R. E. French...	5.00
"	31	M. D. Stewart..	5.00
"	31	C. B. Hutchinson	5.00
"	31	E. T. White....	10.00
Carried forward		...	$2,700.00

Brought forward		......	$2,700.00
Mar.	31	A. E. Tremp ..	5.00
"	31	John Ellis......	5.00
April	1	A. L. Moler....	5.00
"	4	A. S. Grant....	5.00
"	4	G. W. Hepburn.	5.00
"	4	J. I. Krauss....	5.00
"	14	W. F. Dixon...	5.00
"	14	D. S. Smith....	5.00
"	14	John Hawthorne	5.00
"	16	A. B. Withers..	5.00
"	21	J. N. Barr......	5.00
May	3	T. W. Macfarlane	10.00
"	3	Jas. M. Dow...	5.00
"	3	J. G. Beaumont.	10.00
"	3	Chas. Lindstrom	5.00
"	12	John Neville....	5.00
"	12	M. T. Carson..	5.00
"	22	Mord Roberts..	5.00
"	22	T. B. Purves, Jr.	5.00
"	22	Thos. Aldcorn..	5.00
"	22	E. M. Roberts..	5.00
"	22	W. F. Bradley..	5.00
"	22	L. L. Smith....	5.00
"	22	C. A. Thompson	5.00
"	22	C. F. Street....	5.00
"	22	Wm. Lachlan...	5.00
"	22	John L. Smith.	5.00
"	22	D. D. Briggs...	5.00
"	22	A. S. Erskine..	5.00
"	22	H. T. Peyton...	5.00
"	22	A. Gardner.....	5.00
"	22	Jacob Losey....	5.00
"	22	C. H. Doebler..	5.00
"	22	T. A. Summerskill	15.00
"	22	T. H. Symington	5.00
"	22	P. G. Baker....	5.00
"	24	J. W. Roberts..	5.00
		Carried forward...	$2,905.00

Brought forward		......	$2,905.00
May	24	M. B. Parker..	5.00
"	24	C. J. Clifford...	5.00
"	24	Jas. Strode.....	5.00
"	24	R. H. Johnson.	5.00
"	24	J. T. Gordon...	5.00
"	24	J. G. Clifford..	5.00
"	24	J. T. Robinson..	5.00
"	24	E. V. Sedgwick.	5.00
"	26	W. D. Holland..	5.00
"	26	F. G. Brownell..	5.00
"	26	C. L. Aiken....	10.00
"	26	R. English......	5.00
"	26	C. B. Hogsett..	5.00
"	26	C. F. Ward....	10.00
"	26	N. W. Norsworthy.......	15.00
"	31	C. M. Stansbury	5.00
"	31	M. D. Brown...	5.00
"	31	H. G. Hudson.	5.00
"	31	Geo. Thompson.	5.00
"	31	C. W. Lee......	5.00
"	31	A. Buchanan, Jr.	10.00
"	31	Chas. Blackwell.	5.00
"	31	J. W. Sanford..	5.00
"	31	A. Moraga.....	5.00
"	31	W. W. Layman.	5.00
June	2.	F. G. Lauer...	5.00
"	2	E. M. Lake....	5.00
"	2	S. R. Boardman.	5.00
"	2	J. H. Pengelly..	5.00
"	2	C. F. Lape.....	5.00
"	2	W. H. Owens..	15.00
"	9	Wm. Montgomery...........	10.00
"	9	Chas. Graham..	5.00
"	9	Jas. Marchbanks	5.00
"	9	T. E. Cannon..	5.00
"	9	Jas. Carr.......	5.00
			$3,125.00

THE PRESIDENT: Gentlemen, you have heard the report of the Secretary; what is your pleasure? It is customary that the report be received and referred to the Auditing Committee.

Mr. P. H. Peck: I move that the report be received and referred to the Auditing Committee.

The motion was carried.

The President: The next business is the report of the Treasurer.

Treasurer Sinclair: Mr. President and gentlemen,—The duties of the Treasurer during the year have been very light and consisted in drawing two checks — one for $400 and one for $941.10. The balance in the bank shows that we have $2,700.89 to our credit. The statement is as follows:

1901.			
June 27.	Balance on hand	$3,712 90	
	Received from other sources....	30 26	
1902.			
June 30.	Interest to June 30............	62 12	
June 16.	Deposit	236 65	
			$4,041 93
	Cr.		
June 29.	G. L. Fowler	400 00	
July 15.	The H. O. Shepard Co.........	941 04	
			1,341 04
			$2,700 89

Angus Sinclair,
Treasurer.

On motion, the report was received and referred to the Auditing Committee.

The President: The next business is the announcement of the annual dues.

The Secretary: At a meeting of the Executive Committee held Saturday afternoon it was recommended that the dues for the coming year should be fixed at $5 per vote the same as formerly.

The President: What is your pleasure in regard to the recommendation of the Executive Committee?

On motion, the recommendation was adopted.

The President: The next business is the election of an Auditing Committee. Our by-laws on this subject are as follows:

At the first session of the annual meeting an Auditing Committee, consisting of three members not officers of the Association, to be nominated by any member who does not hold office, shall be elected in the same way as officers are voted for. This Auditing Committee shall examine the accounts and vouchers of the Treasurer and certify whether they have been found correct or not. After the performance of this duty they shall be discharged by the acceptance of their report by the Association.

It will be in order, if it is desired, before any nominations are made, for a motion to be made that when the ballot is taken that the Secretary cast the ballot of the Association separately for such members as may be nominated. Such a motion will be received if it is the pleasure of the house. Of course, if there is any objection it cannot be received or prevail.

MR. J. L. LAWRENCE: I move that the Secretary be authorized to cast the ballot, separately, for the nominees.

The motion was carried.

THE PRESIDENT: Nominations for the Auditing Committee are now in order.

The following named gentlemen were nominated: F. M. Whyte, David Brown, F. A. Chase.

MR. P. H. PECK: I move that the nominations be closed.

The motion was carried.

THE SECRETARY: I cast the ballot for the gentlemen named for the Auditing Committee. The books of the Secretary and Treasurer are on the desk ready for inspection whenever desired.

THE PRESIDENT: Is there any unfinished business? (No unfinished business.)

THE PRESIDENT: New business is in order.

Secretary Taylor read the following communication from Mr. A. J. Pitkin, vice-president of the American Locomotive Works.

AMERICAN LOCOMOTIVE COMPANY.

SCHENECTADY, N. Y., May 7, 1902.

Mr. J. W. Taylor, Secretary, American Railway Master Mechanics' Association, 667 Rookery Bldg., Chicago, Ill.:

DEAR SIR,— In former years when the American Railway Master Mechanics' Association convened at Saratoga, we have had the pleasure of a visit from the Association at our Schenectady Works. We feel that we

have now, more than ever, an attraction at Schenectady in the way of a modern plant, and we would be very glad if it can be arranged for a visit from the Association to our Works, at some convenient time during the meeting at Saratoga this year. Will you, therefore, kindly extend an invitation to the Association to visit us and we will be pleased to arrange for a suitable train and light lunch at Schenectady. Yours very truly,

A. J. PITKIN, Vice-President.

THE SECRETARY: The Executive Committee considered this communication at a meeting held on Saturday, and suggested, if it is desirable to accept the invitation, that the afternoon of Tuesday be selected, and the hour be as near 1 o'clock as possible. To do this it would be advisable for the convention to meet at 9:00 instead of 9:30 o'clock and adjourn at 12 o'clock.

THE PRESIDENT: I might add, further, that the general superintendent of the Schenectady works told me that the lunch will be a luncheon at which we shall be seated, so that it will not be simply light refreshments, but that it will be ample and we need not wait for our luncheon at the hotel.

MR. E. A. MILLER: I move that the invitation be accepted, and the hour of meeting for Tuesday be changed from 9:30 to 9:00 o'clock and that we adjourn at 12 o'clock.

The motion was carried.

THE PRESIDENT: Another item under the head of new business is a recommendation for associate membership as follows:

We recommend for associate membership in this Association Mr. Joseph W. Taylor.

A. M. WAITT.
GEO. W. WEST.
AUGUS SINCLAIR.

According to the constitution, this will lie over a year for action at our next meeting.

THE SECRETARY: The Executive Committee would propose the following gentlemen for honorary membership in the Association: Mr. Amos Pillsbury, Portland, Maine, a member since 1878; Mr. James Strode, Elmira, N. Y., a member since 1875; Mr. Charles Blackwell, Cleveland, Ohio, a member since 1883.

On motion they were declared elected.

THE SECRETARY: The Executive Committee recommends a change in section 1 of the by-laws which reads as follows: "The regular meeting of the Association shall be held annually on the third Tuesday in June." Owing to the fact that we now meet alternate years with the Master Car Builders' Association, it has been found impracticable to arrange our meeting on that date. Your committee would therefore recommend that the section be changed to read "The regular annual meeting of the Association shall be held in June of each year," instead of specifying the third Tuesday.

Your committee proposes an amendment to section 2 as follows: "Section 2. The regular hours of the Association shall be from 9:30 A.M. to 1:30 o'clock P.M."

Your committee also propose the following change in section 3, making it read as follows: "Time and place for holding the annual convention shall be selected by a joint committee composed of the president, three vice-presidents and treasurer of this Association and a corresponding committee from the Master Car Builders' Association. The committees shall meet within six months after the convention and decide on the time and place of the meeting."

THE PRESIDENT: You have heard the recommendation of the Executive Committee in accordance with instructions given them at the last meeting in regard to these changes in the by-laws. These changes can be made by a majority vote of the members present. What action will you take? This is merely changing the by-laws to what is found to be practicable instead of having the by-laws different from the practice.

The recommendation of the Executive Committee was adopted.

THE SECRETARY: I have the following communication from John D. Woodward, ex-assistant-commissioner-general of the United States at the Paris Exposition:

UNITED STATES COMMISSION TO THE PARIS EXPOSITION OF 1900.
ROOM 672, 32 LIBERTY STREET.
NEW YORK, March 12, 1902.

American Railway Master Mechanics' Association, Chicago, Ill.:

GENTLEMEN,— I have the honor to send you herewith the medal awarded to you in Class 32 at the Paris Exposition. You will note that

irrespective of the nature of the award the medal is uniformly bronze, the diploma, which will follow in due course, specifying the grade. Kindly acknowledge receipt, and oblige,

Yours truly,
B. D. Woodward.

A bronze copy of the medal is on the table for the inspection of the members. If it is the desire of the members that the medal in gold be procured, it would cost $145.00. I also have the diploma of award which, with the medal, will be reproduced in the report of proceedings. (The diploma is shown on next page.)

Mr. J. L. Lawrence: If I remember, at the meeting of the Master Car Builders' Association, a resolution did not prevail to expend that amount of money, and if my memory serves me rightly the Master Car Builders' Association has considerably more money in its treasury than we have. I would move you, therefore, that the expenditure be not made.

The motion was carried.

The President: I appoint the following committees: On Correspondence and Resolutions: J. H. McConnell, F. M. Whyte and L. R. Pomeroy.

Committee on Subjects, 1903: D. F. Crawford, G. R. Henderson and C. H. Quereau.

Committee on Obituaries: For Angus Brown, James McNaughton; for W. L. Hoffecker, William McIntosh; for J. H.


ARTS
RÉPVBLIQVE FRANÇAISE
MINISTÈRE DU COMMERCE DE L'INDUSTRIE DES POSTES ET DES TÉLÉGRAPHES
MÉDAILLE D'OR
AMERICAN RAILWAY MASTER MECHANICS ASSOCIATION
GROUPE VI. — CLASSE 32
ÉTATS-UNIS

Buckalew, R. H. Briggs; for Jerome Wheelock, G. A. Coolidge; and for J. H. Leeds, G. M. Basford.

The President: The first report to be taken up is that of "Ton-Mile Statistics." The report is in your hands. The Chairman of the committee is absent and I will call on Mr. Quereau to present the report.

Mr. Quereau presented the following report:

REPORT OF COMMITTEE ON TON-MILE STATISTICS.

To the President and Members of the
American Railway Master Mechanics' Association:

Resolutions adopted.

When this committee was first appointed to report to the convention of 1899, the title of its subject was: "Advantages of the Ton-Mile Basis for Motive Power Statistics." By some method of evolution the subject title has been changed to "Ton-Mile Statistics," and perhaps properly so, for the reason that the convention of 1899 accepted the ton-mile basis by passing the following resolution:

"*Resolved,* That it is the sense of this Association that the ton-mile basis for motive power statistics is the most practical and encourages economical mehods of operating, and that it is desirable that the heads of motive power departments urge its adoption on their managements."

This, so far as the Association is concerned, practically disposed of the question as to the *advantage* of the ton-mile basis, and the adoption of the ton-mile basis in some form within the past few years by several large railway systems has proven the wisdom of the action taken by this Association, and we think there are few, if any, members of this Association who will now oppose the ton-mile basis as being the best basis for motive power statistics.

Further investigation of this matter by your committee, under the subject title of "Ton-Mile Statistics," develops complex questions and conflicting opinions as to what the statistics should include.

It has been thought wise to confine the present report to discussion of the general principles involved, in the belief that with these settled, the details can be worked out to better advantage afterward, and numerous chances of confusion and an unnecessarily prolonged discussion be avoided.

It may seem out of place that an association of motive power officers should venture and discuss opinions concerning operating department statistics; but in view of the fact that this Association was among the first to discuss the question of statistics on the ton-mile basis, and has constantly urged their use, that this basis is not as generally used for operating as for motive power statistics, that we are convinced that its general use for the operating department would result as beneficially as experience

has shown it has for the motive power department, and that the use of the same basis for both departments will further result in economies in the statistical department we venture our opinions and suggestions.

In considering this subject, we should view it in the light of what the statistics should include to best promote and suggest motive power economies; should statistics include all classes of service, as passenger, freight, switching and work train? In computing ton-mileage should weight of locomotive, tender and caboose be included? Should statistics be segregated to show main line and branches separately? Should passenger and freight business be divided into fast and local?

While your committee is not in harmony on all these points, it is deemed advisable to present an argument covering all the questions, and request action thereon by the Association.

ARGUMENT.

COMPARISON OF STATISTICS.

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tistics.

To those who have not studied the matter carefully, or have studied it only from an office or theoretical standpoint, without having had the advantage of intimate practical experience, it would not be surprising if a comparison of the statistics of two railroads seems a logical thing to make, and a fair basis for drawing conclusions. But the more the matter is studied, the more evident it will become that the old adage, "Circumstances alter cases," is eminently applicable to railroad statistics. If, to a thorough study of the matter, is added an extended experience, with the effect of various elements, making up the total cost of operating, it will not be surprising if the student agrees with the comparisons made by a well-known railroad official: "Positive, lies; comparative, damned lies; superlative, statistics."

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ration.

Only those who have had the experience can appreciate the influence of water, fuel, weather conditions, grades, curvatures and climate on the cost of operating. Any one of these elements may easily produce a difference in cost which will surprise the uninitiated. Take the item of grade. Assume that five pounds is the drawbar pull necessary to keep a ton of train in motion at a speed of eight miles per hour on a level track. The introduction of a grade as slight as one-fourth of one per cent, or 13.2 feet per mile, doubles the resistance per ton, reducing the capacity of a given locomotive from one thousand to five hundred tons, and doubling the operating and motive power costs per ton-mile. While it is not possible to show the influence of variations in water, fuel, climate, etc., as closely as in the case of grades, none the less the effect of each is real and important, best appreciated by those who have studied it at first hand under service conditions.

For the reasons given, it is entirely safe to say there are scarcely two divisions on any railroad where the statistics are fairly comparable without taking into account the influences of water, fuel, grades, volume of busi-

ness, capacity of locomotives, and a great number of variables, the influence of any one of which it is very difficult to give its exact or even approximate value. If there is so much uncertainty in comparing the statistics of two divisions of the same system, how much more when the comparison is made between railway systems, when, of necessity, the unknown conditions further complicate matters. By far the largest proportion of the uncertainty is eliminated when a comparison is made of the statistics of a given division or system with those of the same territory for a corresponding previous period. In such a comparison the conditions are the same, or any change is known, making it possible to draw fairly reliable conclusions from a comparison of statistics. It was, no doubt, this line of reasoning and the experience of the members of the Association growing out of unjust conclusions drawn from a comparison of statistics made under dissimilar conditions, which led the American Railway Master Mechanics' Association to unanimously pass the following resolution at its session in June, 1901:

"*Resolved,* That it is the sense of this Association that a strict comparison of motive power statistics, one road with another, will not secure the best results, but that such comparison should be made with the records of the same division for preceding periods of time."

It would be a mistake to assume from the foregoing that it is the intention to urge that a comparison of the statistics of different railroads should not be made, or if made, that they will be of no value. The intent is to call attention to the fact that conclusions based on such a comparison may easily prove incorrect, should be given less weight than they usually are, are fair only when the accompanying conditions are fairly well known and their influence can be determined with some degree of accuracy, and that the comparison of the statistics of a division or system with those of the same territory for a previous corresponding period, very largely eliminates the uncertainties, and makes conclusions based on such a comparison very much more reliable, hence productive of better results than the usual comparison of the statistics of different systems. Doubtless railroad statistics have been compared ever since the completion of the second railroad and still will be, but it has been only within comparatively recent years that the subject has been given the attention and study its importance deserves. The American Railway Association, the Association of American Railway Accounting Officers and the Interstate Commerce Commission, through their statistician, have done much to introduce standard methods of compiling statistics, thereby largely removing the sources of error due to lack of uniformity, but there still remains the fact that the units of comparison are very unsatisfactory, and it will not be at all surprising if the next few years will see these radically changed.

UNITS OF STATISTICS.

It is evident, from the published discussions on the subject, that there is a growing conviction in the minds of those studying the subject, that

the units for railroad statistics should be such as to measure as closely as practicable the work done, and that the basis of comparison should be the cost per unit of work done.

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Work is measured by the unit horse-power, which is the power required to raise thirty-three thousand pounds one foot in one minute, and therefore contains the elements of weight, distance and rate of speed. The element distance alone has until comparatively recently, been used as the unit, as in the engine-mile and train-mile, which in reality are only units of distance, as the engine and train can not be properly considered units because they have no fixed value.

In the past few years the foolishness of using distance as a measure of a railroad officer's efficiency has become apparent, and the ton-mile has been substituted because it includes the very essential element of weight in addition to distance.

Of late it has been suggested a number of times that the unit of statistics should measure the work done still more closely by including the only element of the horse-power lacking in the ton-mile, namely, rate of speed. No doubt those who have made the suggestion have had in mind not only the fact that such a unit would be ideal, but have known the increased operating efficiency resulting from the substitution of the ton-mile for the mile as a unit, and realized that this greater efficiency is due to the fact that a ton-mile is a much closer measure of work than the mile. One such suggestion has been made in substance as follows: "The theoretical maximum horse-power of a locomotive can be calculated. A comparison of the actual horse-power obtained in service, with the possible horse-power, would furnish a closer measure of operating efficiency than a comparison of actual and possible ton-mileage." It is very doubtful if those who reason in this way have an adequate conception of the cost and difficulties involved in determining the actual power developed. It would involve determining the average drawbar pull behind the tender, and the average speed between locomotive terminals for each locomotive in service. To do this at all accurately would necessitate the use of a combined dynamometer and speed recorder, which would automatically register the pull, push and speed; one of these instruments for each end of each locomotive. Considerable time and talent have been spent in trying to design a dynamometer to be attached to locomotives, which would record the pull and push exerted to be put into service and take care of itself; as it evidently would not pay to have an attendant with each locomotive. So far these efforts have been unsuccessful. Those who have made use of a dynamometer car in conducting special locomotive tests know that the apparatus needs almost constant attention, and probably will be skeptical as to the successful outcome of the effort to design an independent dynamometer, capable of registering the pull and speed of locomotives.

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But assuming that such an instrument is available, it will be necessary that it be a calculating machine, and register the *average* pull and speed, or these factors must be determined after the records are made, in order

to determine the horse-power developed. Assuming that we have the average pull and speed, no matter how obtained, these must be multiplied together, and the product by the distance through which the pull was exerted, and then divided by 33,000 to find the desired horse-power. It is evident that the problem is a difficult and costly one to solve. It is at least safe to assume that its immediate solution is not probable, and the plan need not be considered for use in making up the statistics of the next few years. It would seem more practicable to determine the average speed of trains from the train sheets, or by means of a speed register in the caboose, but it is very doubtful if the resulting horse-power would be a much better basis than the ton-mile, at least of sufficient advantage to warrant the additional expense. If the average speed is determined from the train sheets, it evidently will take considerable time, as it will be necessary to subtract the time lost on side tracks from the time between terminals, and this waste time is frequently a third of the total time between terminals. The finding of the time wasted in this way is further complicated by the fact that there are a considerable number of blind sidings, without telegraphic communication with headquarters, and the time lost at such places should not appear on the train sheets, and would either not be taken into account or have to be reported by the conductor.

Several roads now have speed recorders in their cabooses, commonly known as "Dutch clocks," by which to check the speed, usually the maximum.

It would be practicable to use the records of these instruments to determine the lacking element of speed, but as it is the average speed which is needed, it would involve expense to obtain this, assuming that all roads would be willing to equip their cabooses and baggage cars with the instruments.

In view of these facts, it would seem wise to postpone the introduction of a unit of statistics, including the average speed, until it has been shown that the use of the ton-mile unit has accomplished all that is possible in increased efficiency, and that a horse-power will secure further economics. Meanwhile it seems reasonable to believe that a grouping of statistics, according to speeds, will make up considerably for the fact that the ton-mile unit does not include the element of speed. The matter of grouping statistics will be discussed somewhat more fully farther on.

TON-MILE STATISTICS.

The use of the tonnage rating and of ton-mile statistics has been introduced and quite rapidly extended in the past few years. This is undoubtedly true because the ton is a very much more accurate measure of weight than the car, which was previously used in making up trains, and the ton-mile decidedly a closer measure of the work done by a locomotive than the previous basis of miles run. In view of the fundamental fitness of the ton and the ton-mile units it would naturally be supposed that they would be used as a basis for more statistical purposes than they are. For instance:

While a number of roads use a tonnage rating, the results obtained by the operating department are frequently judged by the number of cars per train and the cost per train-mile; and if the ton-mile is used as a basis for motive power statistics, it is frequently confined to freight locomotives.

MOTIVE POWER STATISTICS.

Passenger Service:

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The usual argument advanced by those who do not use the ton-mile basis for passenger locomotive statistics is that the speed and weight of passenger trains are not under the control of division officials, but are fixed by general officers not immediately responsible for results, whose decisions are controlled by competitive necessities, implying there is little use in trying to improve records in this service, and therefore little use for accurate statistics. Assuming this to be a valid reason, the logical deduction to be made is that passenger locomotive statistics should not be kept at all. It is quite certain that no superintendent of motive power, much less his superiors, would be willing to act on this conclusion. They would undoubtedly argue that, though the opportunities for savings are much less in passenger than in freight service, yet improvements are possible and desirable, and without statistics they would be working entirely in the dark. If this conclusion is correct, it follows that, if the ton-mile basis has decided advantages for freight locomotives there is no inherent reason why it has not for passenger locomotives, though the gross and possibly the percentage of saving in the latter service may not be so great.

A consideration of service conditions will show that the speed and weight of trains for a considerable portion of freight service are quite as much under the influence of competition as in passenger service. The fastest possible time consistent with safety is apparently the rule for stock trains; fruit trains must be at their destination within a specified number of hours or the traffic is lost; merchandise must be delivered at competitive points promptly or it will be routed another way; through business must be handled expeditiously or some other trans-continental line will get it; fuel and ores for manufacturing purposes, steel works and smelters must be handled with dispatch or the consequences are disastrous to future business. Though these classes of freight make up no small percentage of the total, the competition dictates the speed and this limits the tonnage. These facts apparently have little weight as reasons for not employing the tonnage basis for freight locomotive statistics, nor are they preventing its rapid introduction. Then why should they be given controlling importance as reasons for not using the ton-mile basis for passenger locomotive statistics?

The first use of motive power statistics on the ton-mile basis was in connection with the fuel records of enginemen, and on a number of roads this is still the only use made of them. It is a matter of common knowledge that some men are more economical than others, even in passenger service. If the use of the ton-mile basis is better than the engine-mile

basis for determining their relative efficiency in freight service, and so bettering records, why should it not be equally valuable in passenger service? If valuable in improving fuel records, why not for the other items making up the cost of locomotive service?

Work Train Service:

There is no difficulty in determining quite closely the amount of ton-mileage that should be credited work train locomotives, as the weight of the train can be obtained as readily as that of freight trains and the mileage can be very accurately approximated. Such a credit of ton-mileage would certainly be more accurate than of an arbitrary mileage per hour, the usual credit. This being true, there appears no valid reason why statistics of work train locomotives should not be on the ton-mile basis, and its greater accuracy commends its use. **Work train service.**

Switching Service:

The determination of a correct credit for work done by switch locomotives, against which to charge the cost of supplies, wages and maintenance, is somewhat difficult, and the present practice of assuming a certain number of miles per hour is certainly not satisfactory, as it is a matter of chance if the credit represents the work done. The same objections apply to the use of an arbitrary credit of ton-mileage per hour, but with no greater force than the present credit. If the statistics for passenger, freight and work locomotives are based on the ton-mile, it would give a uniform basis for all services if the same unit is used for switching service, with no reasonable objection to it.

Under present practice all locomotives used in switching service, regardless of size and power, are given the same credit. This is manifestly unjust, and it makes it practically impossible to closely judge of their efficiency. It would be much better to establish a standard switch locomotive tractive power, to which a certain credit would be given, making the credit of switch locomotives in proportion to their tractive power. For example: If the standard tractive power is made fifteen thousand pounds, and the credit for this standard is three thousand ton-miles per hour, the credit for a switch locomotive having a tractive power of twenty thousand pounds would be four thousand ton-miles per hour. **Switching service.**

It is quite probable that a reasonable approximation to the actual ton-mileage of switch locomotives can be made if undertaken systematically. At present an effort is being made in the East, by means of revolution counters, to determine the average mileage made by switch locomotives. If, in addition to this record, the tonnage handled is determined, we would have the necessary information for arriving at the ton-mileage. This could not be as accurate as in passenger, freight and work train service, but would, no doubt, be better than the present practice. In view of the considerable expense due to switching locomotives, it would seem worth while to make special efforts to arrive at a just credit for their

work, in order to judge of the returns obtained for the money expended, the same as for locomotives in road service.

COMPUTING TON-MILEAGE.

What Tonnage Should Be Included?

At the meeting of the American Railway Master Mechanics' Association, in 1901, the following resolution was passed unanimously:

"*Resolved,* That it is the sense of this Association that the ton-mileage of the locomotive is a just credit to the motive power department for statistical purposes."

As this resolution was passed after a discussion covering a period of two years, it should carry considerable weight.

In all probability the reason for the unanimous assent to the principle involved is the fact that it was recognized that the proper basis of efficiency is the cost per unit of work done, and that all the work performed should be included. It was no doubt realized that a very large proportion of the total work done by locomotives, and therefore a very large part of the money spent by the motive power department, is due to the locomotives themselves.

On a great many railroads, particularly those with heavy grades, and considerable branch mileage, this unproductive work amounts to a third of the total, and is just as essential in arriving at just conclusions concerning cost as the cost represented by superintendence, watchmen, clerks, heating, taxes, insurance and other essential items. It is probable there is no railroad on which the ton-mileage of the locomotive is less than ten per cent of the total, an amount which should not be overlooked, and which, if profit, would not.

mileage ntire train e included atistics.

Inasmuch as the ton-mileage of the locomotives is a very considerable item on a large number of roads, and it costs at least as much to produce a locomotive ton-mile as a car ton-mile, as it will work no hardship to roads on which the locomotive ton-mileage is a comparatively small part of the total, to include this item, and as the proper basis by which to judge the efficiency of the motive power department is not that of revenue or operating results, but the cost per unit of work performed, it seems eminently just that this department should receive credit for all the work done by it, which will include the ton-mileage of the entire train.

Pusher and Double-heading Service:

The ton-mileage of trains where pusher and double-heading locomotives are used evidently should be divided among the locomotives attached to these trains, and for the distance over which the helping locomotives are used, in proportion to their tractive power.

A locomotive's tractive power is found by the use of the formula $T = \frac{d^2 p s}{D}$, in which T is the tractive power, d the diameter of the cylinder, p the boiler pressure, s the stroke and D the outside diameter of the drivers; all the dimensions in inches and the pressure in pounds.

By the use of a table giving the tractive power of all classes of locomotives, grouped in all possible combinations, an accurate distribution of the ton-mileage of trains using more than one locomotive can be made accurately and rapidly.

Grouping Statistics:

The horse-power, used as a unit of power developed or resistance overcome, combines the elements of time, distance and weight, but the ton-mile includes only distance and weight, leaving out the important factor of speed. While the influence of speed on the cost of locomotive service is considerable, and it may be possible to include it in our statistics, it is very probable it will be considered impracticable because of the expense and delay involved. In lieu of this it will materially increase the usefulness of ton-mile statistics if the various classes of locomotive service are grouped, so that the variations in speed included in each group will be very much less than though the statistics of all classes were thrown together. The groups which naturally suggest themselves are passenger, freight, pusher, work train and switching services, and the first two groups naturally divide themselves into fast and local.

Main and branch line statistics tc kept separa

On the main line, because of the relatively large amount of business done, trains are quite numerous, locomotives quite generally may be loaded to their capacity, trains proportioned to the power of the locomotives and the proportion of local work small, making a minimum cost for locomotive service possible. But on branch lines the conditions are quite different. The amount of work to be done is relatively limited and almost entirely local, the number of trains small, the business fluctuating within wide limits, the locomotives of such power that they can handle the heaviest business, and are therefore too heavy for the average work to be done, conditions resulting in comparatively high cost of locomotive service. Therefore, in order that divisions and systems which have considerable branch line mileage may be fairly judged, it seems quite evident there will be a decided advantage in keeping the statistics of the main line and the branches apart.

Should an Arbitrary Weight Be Added to the Weight of Empty and Partly Loaded Cars?

The ton as a unit for making up trains, using the actual weight of cars, has proven more efficient than the car, because it is more accurate measure of weight, and hence of the work done by the locomotives. For this reason its use has resulted in more uniform and increased trainloads and decreased overtime, reducing costs.

The fact has been established, beyond successful contradiction, that there is no constant relation between the weight of a car and the power required to haul it, but that a ton of empty cars requires more power to haul it than a ton of partly loaded car, and this requires more power than a ton of fully loaded car; also that the greater the capacity of a car the less the power per ton required to handle it when fully loaded.

The ideal system of tonnage ratings would be one which takes these facts into consideration, and would measure accurately the resistance a train will develop, regardless of the number of cars, load, empties or partly loaded cars it contains or their weight or capacity, as it is the resistance a locomotive is capable of overcoming which a tonnage rating should measure, rather than the number of cars or tons it is capable of hauling. Several systems of tonnage ratings which take into account the varying resistance of empty, loaded and partly loaded cars, are in use which have resulted in more uniform trainloads and time between terminals, thus increasing the efficiency of the motive power and reducing costs.

While it is true that a system of adjusted tonnage ratings which endeavor to measure resistance instead of weight produces more efficient operating results, it is still a question whether it will be wise to determine motive power efficiency on the basis of resistance overcome or of weight moved.

tual rather in adjusted nage tistics ferable en compared h other ds.

Considered as a scientific or mechanical proposition there can be no doubt that the basis of resistance is the correct one, as it is the amount of resistance overcome which, other conditions remaining the same, determines the operating cost, but there are several matters which should be considered before arriving at a decision.

In the first place it would be necessary to decide what system of "adjusted" or "equivalent" tonnage ratings should be adopted, and it is doubtful if sufficient experience has been had, or theoretical considerations could at present permanently decide, which is the best. In the second place, the arbitrary addition to the actual weight of the train would have to be different for almost every division of every railway system, because the object of the modified systems of tonnage rating is to measure train resistance, and this varies with the grade and speed.

Theoretical considerations show, and careful tests have proven, that the resistance of a ton of empty cars compared with that of a ton of fully loaded cars, decreases with an increase of grade and increases as the speed increases. Again, that the adjusted tonnage should continue to be as just a basis for ton-mileage, as when established, it will be necessary to change the factors from time to time, as the capacity of the cars increase, because the resistance per ton of train decreases as the capacity of the cars comprising it increase, and car capacity is constantly increasing.

In view of the facts presented it seems best to use the actual rather than the adjusted tonnage for motive power statistics, until a practical method of determining the actual horse-power developed by locomotives, or a single system of adjusted tonnage ratings has been devised, satisfactorily tested and adopted. This conclusion, however, is intended to apply only to such statistics as are to be used for comparison with other roads, for reasons which will appear presently.

Several systems have found from experience that the use of a system of adjusted tonnage ratings has resulted in increasing somewhat the ton-mileage of their locomotives, the uniformity of their trainloads, and short-

ening the time of trains between terminals, thereby increasing operating efficiency.

Adjusted tonnage statistics preferable f comparing same divisi or system fo correspondi periods.

Keeping in mind that the correct unit for motive power statistics is that which most closely measures the work performed, and that this is true of the ton-mileage obtained by using the adjusted tonnage, it follows that the adjusted rather than the actual tonnage should be used. This can easily and fairly be done if the comparison is confined to statistics of the same division or system for corresponding periods, and will be of considerable value in judging operating and motive power results, particularly locomotive fuel and repair records.

It has been urged that the adjusted tonnage should not be used in compiling motive power ton-mileage, because it is always greater than the actual tonnage, and would give a false impression of the business done.

This argument overlooks the fact that the motive power department can not be fairly judged on the basis of revenue, as it has no control of it, but on the basis of cost per unit of work done. It is entirely practicable to judge revenue on the basis of actual tonnage handled and the motive power and operating results on the basis of adjusted tonnage at a nominal expense.

THE BEST BASIS FOR OPERATING STATISTICS.

Ton mile b preferable t car mile or train mile f operating statistics.

The basis should be such that the resulting statistics will furnish not only a correct measure of present efficiency, but show and measure the effects of money spent for reducing costs. Until quite recently the almost universal bases of operating statistics has been the number of cars per train, cost per car-mile, or cost per train-mile. If money is spent in reducing the grade it will result in increasing the number of cars per train, a better showing on that basis and a reduced cost per car-mile, but it will not materially change the cost per train-mile, because it is safe to assume the locomotives would be loaded to their capacity both before and after the grade reduction. It is evident that the cost per train-mile is not as good a basis for operating statistics as the cars per train or cost per car-mile, as it shows no advantageous results of money spent in reducing grades which, as a matter of common sense, the statistics should do.

For handling coal, ore and similar freight, there is no doubt that large capacity cars reduce the cost of transportation. Should capital be invested in the purchase of larger capacity cars, the cost per train-mile would probably not be affected, other conditions remaining the same; and again, this basis would not show the effects of betterments. The effect would be to decrease the number of cars per train and therefore increase the cost per car-mile. The logical conclusion from such a showing would be that it does not pay to buy large capacity cars; a conclusion which at once shows that the bases of cars per train and cost per car-mile are misleading, as the conclusions logically drawn from statistics compiled on these bases are opposed to experience.

If capital is invested in more powerful locomotives it will result in an

increased cost per train-mile, because of increased cost for fuel and repairs, both car and locomotive; again the basis of cost per train-mile is found wanting. Such an investment will result, however, in a better showing on the basis of cars per train and cost per car-mile. In this case, the conclusions which would be drawn from the bases of cost per train-mile and cost per car-mile are diametrically opposed, therefore one or both must be incorrect.

It appears evident from this analysis that the bases of cost per train-mile and cost per car-mile are certain to lead to false conclusions, and in none of the cases cited were the conclusions reached the same from these two bases.

If the ton-mile, either as ton-miles per locomotive or cost per ton-mile is used as a basis for operating statistics, it will show the benefits of grade reduction, more powerful locomotives and larger capacity cars, both in increased ton-mileage per locomotive and reduced cost per ton-mile, as a little thought will show.

In view of these facts, it seems evident that the ton-mile basis for operating statistics is far better than either the train-mile or car-mile; simply because it records intelligently and without a comparison of several sets of statistics on different bases, the actual work done and the benefits accruing from capital invested in betterments.

Acting under authority given it at the convention of 1901, your committee corresponded with the American Railway Association and the American Railway Accounting Officers, and learns that while both of these associations have committees on mileage statistics at work, nothing definite has been decided upon as regards ton-mile statistics, and it is the belief of your committee that any action taken by this Association at this time would receive the careful consideration of the above associations. The statistician of the Interstate Commerce Commission also expressed interest and promise of coöperation.

The following resolutions embody the general principles on which your committee requests the action of the Association, with a view to presenting the results of such action to the American Railway Association for its approval:

As a substitute for the following resolution, passed by the Association in June, 1901:

"*Resolved,* That it is the sense of this Association that a strict comparison of motive power statistics, one road with another, will not secure the best results, but that such comparison should be made with the records of the same division for preceding periods of time."

We offer the following as conveying the same idea in a better way:

"*Resolved,* That it is the sense of this Association that conclusions based on a comparison of the statistics of one railroad with another may easily prove incorrect, should be given less weight than they usually are, are just only when the accompanying conditions are fairly well known and their influence can be determined with some degree of accuracy; that

a comparison of the statistics of a division or a system with those of the same territory for a previous corresponding period very largely eliminates these uncertainties and makes conclusions based on such a comparison much more reliable."

To make the record complete, we include the following, passed unanimously in June, 1901:

"*Resolved,* That it is the sense of this Association that the ton-mileage of the locomotive is a just credit to the motive power department for statistical purposes." **Resolutions**

We would amend this by inserting the words "and caboose" after the word "locomotive."

"*Resolved,* That the ton-mile is the best practical basis now available for motive power and operating statistics by which to judge the efficiency of locomotive and train service.

"*Resolved,* That actual tonnage should be used in computing ton-mile statistics for comparison with those of other roads, but for comparison with the previous records of the same system or division the use of adjusted tonnage is advisable.

"*Resolved,* That the statistics of passenger, freight, work train and switching services should be on the ton-mile basis, each service in a separate group, and passenger and freight service to be each further grouped under Through and Local.

"*Resolved,* That the statistics of branch lines and main lines should be kept separately.

"*Resolved,* That the credit of ton-mileage for locomotives in switching service should be proportional to their tractive power.

"*Resolved,* That the ton-mileage of trains using more than one locomotive should be divided among the locomotives attached to these trains in proportion to their tractive power and for the distance over which the helping locomotives are used.

"*Resolved,* That the tonnage of the locomotive should be its weight in working order, plus the light weight of the tender and half its capacity of coal and water."

H. J. Small, Chairman,
C. H. Quereau,
G. R. Henderson,
Geo. L. Fowler,
Committee.

Sacramento, Cal., May 19, 1902.

Mr. C. H. Quereau (N. Y. C. & H. R. R.): The report is really a discussion of the matter of ton-mile statistics summarized in resolutions, with the view of having these resolutions acted upon by this convention, and if the action is favorable, that the resolutions shall be presented to the American Railway Association. I believe the Master Mechanics' Association now has an

opportunity to make a record for itself—not a record, exactly, but to give itself a standing it has not had before. I believe that this Association can claim credit for having studied more carefully and analytically the question of ton-mileage, tonnage ratings and ton-mile statistics than any other Association. So far as I know, and my knowledge includes the American Railway Association, the Interstate Commerce Commission, and the Association of American Railway Accounting Officers, there has been no proposition made relating to ton-mile statistics. I believe the experience of this Association and those who have studied the matter, and some of them may be members of other associations, warrants the conclusion that the time is now ripe for putting the statistics of the railroads of the country, both motive power and operating, on a ton-mile basis, and that this will be one of the most important reforms ever instituted.

I will not undertake to read the report in detail. It is a discussion of the question, as I have indicated, and unless it has been read it cannot well be discussed, and even if it were read now it could not be intelligently discussed, I think, simply from hearing it read once or reading it over once. There are one or two matters, however, I would like to call attention to, and I will read a few paragraphs of the report from the beginning.

Mr. Quereau (while reading from page 12) said: I may interrupt the reading of the report to say that I have had several interviews with the Secretary of the American Railway Association, the statistician of the Interstate Commerce Commission, and the President of the American Railway Association, and they are all in hearty sympathy with the movement which has been inaugurated and developed by this Association, and each expressed the opinion that now was an opportunity for the American Railway Master Mechanics' Association to place itself in good standing, in a better standing than they have ever had, and be the means of bringing to pass what very many railway officials consider a general proposition worthy of development.

You will notice in the resolutions as indicated in the first part of the report that only general principles have been discussed and that the resolutions cover only general principles. There is a great mass of detail which could easily be discussed for the

full time of the meeting of the Association, but that, your committee believes, would be a waste of time. We have, therefore, undertaken to present the matter in a series of resolutions covering the general principles.

The President: Gentlemen, you have heard the report of the Committee on Ton-mile Statistics; what action will you take upon their report?

Mr. L. T. Canfield: I move that the report be received and opened for discussion.

The motion was carried.

The President: Among other things it will be noticed there are certain resolutions which the committee presents and hopes will be adopted individually, and as a whole; and I would suggest that special consideration be given to these suggestions, so that whatever action is taken may be taken understandingly, and that the resolutions may be properly taken up one by one.

Mr. D. Van Alstine (C. G. W. Ry.): I would ask Mr. Quereau why he wants to make comparison between different roads on the actual tonnage basis and previous records on the same division on adjusted tonnage basis—I do not see why that is necessary. Why should we not compare records on different roads on the adjusted tonnage basis?

Mr. Quereau: It was not so intended. If Mr. Van Alstine will read the report he will see the reason. The adjusted tonnage, as has been discussed here, does not represent the actual tonnage handled, but includes a certain percentage added to the actual weights of light cars and for the different loadings of loaded cars. If the same system of adjusted tonnage was in use on all roads such a comparison could be made, but so far as I know, or any other member of the committee knows, although there are several systems of adjusted tonnage ratings, the same system is not in service on more than one road. Therefore such a comparison would not be fair, and would really be impracticable.

Mr. Van Alstine: Would not any system of adjusted tonnage be a more accurate comparison than ordinary ton-mileage system?

Mr. Quereau: I am very much inclined to doubt that, because

the adjusted tonnage takes into consideration grades, speeds and curves, and as these vary, even on different divisions of the same system, it is more than probable the adjusted tonnage ratings would differ materially on different roads. For instance, the difference between the power required to haul a ton of light cars and loaded cars decreases with an increase in grade; in other words, the difference between the power required to haul a ton of light car and a ton of loaded car on a 2 per cent grade is less than on a 1 per cent grade, and that is less than on a one-half of 1 per cent grade. The difference between those two classes of tonnage is less the slower the speed, and is greater the higher the speed. For instance, at 30 miles per hour, it requires approximately 50 per cent more power to haul a ton of light car than a ton of loaded car, while it would be reduced to 7 or 8 per cent at a speed of eight or ten miles. You can see the difficulties we would get into if we use any comparison for different railroads, based on the ton-mile statistics derived from these adjusted tonnage ratings. Now coming to the comparison of statistics for a given division, the conditions are settled and would remain the same on the division year after year, or whatever changes there might be in grades or average speed would be known, and would be a legitimate feature to be included in the statistics for that division.

MR. T. H. SYMINGTON: It seems to me that the first resolution here is one that will not be approved of by the American Railway Association: "That it is the sense of this Association that a strict comparison of motive power statistics, one road with another, will not secure the best results, but that such comparison should be made with the records of the same division for preceding periods of time."

MR. QUEREAU: We have a substitute for that resolution, which appears on page 13.

MR. SYMINGTON: The sense of the second resolution is largely embodied in the first. We will take the second. Statistics have no value in themselves at all. What we are after, of course, is improved service on the railroad with which we are connected. Should a manager go to a new line he would be able to accomplish very little by comparing his statistics with the statistics that had been obtained a year or two previously, if these statistics of the

previous year had been made under very poor conditions. I do not see how it is possible for a railroad to very much improve its operating conditions unless it does compare its statistics with those of another road, where they may be using larger locomotives and have eliminated their grades and thus consider the question in a broad, general way. I know of a very modern up-to-date railroad which is operating in a very economical way and the general superintendent of that road heard of another road that was handling its trains in a very much more economical way, some four or five hundred miles distant. He sent some men over to the other road to investigate and see how they were doing, to look up the statistics, etc., and the result was that a very material improvement was made on his line. I do not think that improvement would have been made if he had not found that some other railroad was doing very much better work than his own road. If we go along this year and make a certain record, and next year we make 10 or 20 per cent improvement, we are satisfied; whereas it might have been possible to have made 50 per cent improvement by comparing our operation with a road which was run upon a better plan. I do not think the American Railway Association will say it is proper to eliminate comparisons between different railroads.

MR. VAN ALSTINE: The committee fully covers Mr. Symington's point when it says the comparisons should be made when the conditions are known; otherwise it is absolutely impossible to make comparisons.

I want to refer again to the point I raised. As I understand it, no roads make any adjustment of tonnage on the speed basis. I do not think they take that into consideration and I think it would be a great mistake to do it. It seems to me in addition to that, it would be a good deal of an undertaking to keep complete statistics on a straight ton-mile basis, and on the adjusted tonnage basis. We ought not to recommend that we do both. If it is a fact—and I believe it is—that the adjusted tonnage basis is nearer accurate, it seems to me that we ought to base everything on the adjusted tonnage for comparison between different roads.

THE PRESIDENT: Is there any further discussion, or action to be taken on the resolution presented by the committee?

MR. G. W. WEST (N. Y. O. & W. R'y: In reply to the state-

ment of Mr. Van Alstine, I will say that unless he looks into that matter carefully, he will find that it will make a difference in the tonnage rating of an engine whether he hauls a train at six miles an hour or sixteen miles an hour.

MR. VAN ALSTINE: I understand that, but it is not safe to say the fastest trains consume the most coal per ton-mile. Fast trains of light tonnage which get over the road quickly, making few stops, are quite likely to consume less coal per ton-mile than slower trains of heavy tonnage, frequently taking side tracks for superior class trains.

Comparing passenger trains with each other and freight trains with other freight trains, it will generally be found that the train requiring the longest time to get over the road consumes the most coal per ton-mile.

MR. C. A. SELEY: Inasmuch as there are a variety of resolutions here, covering several phases of this question, in order that they may be taken up systematically, I move the adoption of the first resolution.

THE PRESIDENT: A motion is made and seconded that the Association adopt the first resolution, which reads as follows:

"*Resolved,* That it is the sense of this Association that conclusions based on a comparison of the statistics of one railroad with another may easily prove incorrect, should be given less weight than they usually are, are just only when the accompanying conditions are fairly well known and their influence can be determined with some degree of accuracy; that a comparison of the statistics of a division or a system with those of the same territory for a previous corresponding period very largely eliminates these uncertainties and makes conclusions based on such comparison much more reliable."

MR. QUEREAU: I do not desire to break in upon the continuity of the discussion, but a point which Mr. Symington raised may properly come in for consideration at this point. I would call Mr. Symington's attention to the last paragraph on the bottom of page three of the report, and call the attention of other members who may have the same opinion that he does. The paragraph says:

It would be a mistake to assume from the foregoing that it is the intention to urge that a comparison of the statistics of different railroads should not be made, or if made, that they will be of no value. The intent is to call attention to the fact that conclusions based on such a comparison may easily prove incorrect, should be given less weight than they usually

are, are fair only when the accompanying conditions are fairly well known and their influence can be determined with some degree of accuracy, and that the comparison of the statistics of a division or system with those of the same territory for a previous corresponding period, very largely eliminates the uncertainties, and makes conclusions based on such a comparison very much more reliable, hence productive of better results than the usual comparison of the statistics of different systems.

We recognize the fact that statistics will be compared, and such comparison will be valuable. We undertake, however, to caution those who make comparisons that they may be easily led astray, and this resolution was asked to be substituted for the one passed in June, 1901, thinking the one passed at that meeting might not be as clear as the one now proposed. I will say, however, although I am not informed as to what action may be taken by the American Railway Association in regard to the matter under discussion, yet I know that several of the leading members of the American Railway Association take exactly the same ground that is covered by this resolution. They say that injustice has been done to them, and the men under them, because their superior officers and boards of directors have not taken into consideration the fact that the conditions were different. They have suffered as well as we have under this sort of thing, and it is a matter of caution in making these comparisons that we offer this resolution.

The motion was put on the first resolution and it was adopted.

THE PRESIDENT: The first resolution is adopted; what is your pleasure in regard to the others?

MR. SYMINGTON: I move the adoption of the second resolution as amended by the committee.

THE PRESIDENT: It is moved that the second resolution, reading

Resolved, That it is the sense of this Association that the ton-mileage of the locomotive and caboose is a just credit to the Motive Power Department for statistical purposes, be adopted.

On motion the resolution was adopted.

THE PRESIDENT: What action regarding the third resolution as recommended by the committee, which reads:

Resolved, That the ton-mile is the best practical basis now available for motive power and operating statistics by which to judge the efficiency of locomotive and train service.

On motion the resolution was adopted.

THE PRESIDENT: The next resolution is as follows:

Resolved, That actual tonnage should be used in computing ton-mile statistics for comparison with those of other roads, but for comparison with the previous records of the same system or division the use of adjusted tonnage is advisable.

MR. JOHN MACKENZIE: What is meant by the "actual tonnage"?

MR. QUEREAU: The ton-mile is obtained by multiplying the tons hauled by the number of miles over which the tonnage is hauled. A few railroads in the country have what they call an adjusted tonnage rating, which adds certain weights, depending on the conditions on the various roads, to the actual weights of the car. By actual tonnage mileage is meant the actual tonnage, multiplied by the mileage. By adjusted ton-mileage is meant the adjusted tonnage (which in every case, as far as I know, gives a larger tonnage on paper than the actual tonnage hauled) multiplied by the mileage.

I would say, Mr. President and gentlemen, in line with what Mr. Van Alstine has to say—this expresses our beliefs after a discussion; I mean whatever resolutions may be adopted by this Association are not the personal views of any of the members, they then become the expression of the Association, recommended practice, if you please, although our action does not establish any standard. This will go now, assuming that the wishes of the committee are acted on, to the American Railway Association, and it is for them to say what we shall do, because we can simply urge our views, define and express our opinions; so that we do not change our present method of keeping these statistics by passing these resolutions.

On motion the resolution was adopted.

THE PRESIDENT: The next resolution reads as follows:

Resolved, That the statistics of passenger, freight, work train and switching services should be on the ton-mile basis, each service in a

separate group, and passenger and freight service to be each further grouped under Through and Local.

What is your pleasure?

MR. JOHN MACKENZIE: I ask the committee in what way shall we keep the ton-mileage of a switching engine?

MR. QUEREAU: It will come later in this way. In our report we call attention to the fact that we have presented only what you might call general principles, and among these general principles is a resolution to the effect that the credit of ton-mileage for locomotives in switching service should be proportional to their tractive power. If that is passed upon it will establish a general proposition which has not been used on any system so far as I know. It then becomes a matter of detail to determine upon some method of arriving at the proper ton-mileage credit for switch engines, but the committee has not gone into that detail in this report, thinking there would be too much discussion, which would occupy too much time. The logical thing would be to appoint a committee next year, if the suggestions are adopted, the committee to determine the proper credit in ton-mileage for switching engines; but I believe it is unwise to discuss the matter in connection with these resolutions.

MR. WEST: Have you taken into consideration the tonnage of the locomotive?

MR. QUEREAU: There is a resolution which covers that—the last resolution.

The resolution under consideration was adopted.

THE PRESIDENT: The next resolution is:

Resolved, That the statistics of branch lines and main lines should be kept separately.

The resolution was adopted.

THE PRESIDENT: The next resolution reads as follows:

Resolved, That the credit of ton-mileage for locomotives in switching service should be proportional to their tractive power.

What is your pleasure in regard to it?

MR. J. L. LAWRENCE: I move the adoption of the resolution.

MR. QUEREAU: I will suggest that if this resolution is adopted it was the idea of the committee that we would have to adopt an arbitrary credit for ton-mileage of switching locomotives, and this involves that assumption, because if we could devise some actual method, the ton-mileage would be proportioned to the tractive power and work done. We contemplate some arbitrary credit. Your committee cannot see any other way out of it.

The resolution was adopted.

THE PRESIDENT: The next resolution reads as follows:

Resolved, That the ton-mileage of trains using more than one locomotive should be divided among the locomotives attached to these trains in proportion to their tractive power and for the distance over which the helping locomotives are used.

The resolution was adopted.

THE PRESIDENT: The last resolution is:

Resolved, That the tonnage of the locomotive should be its weight in working order, plus the light weight of the tender and half its capacity of coal and water.

On motion, the resolution was adopted.

MR. ANGUS SINCLAIR: I move that the resolutions be adopted as a whole.

MR. QUEREAU: If I may be allowed, I would like to make a suggestion—I do not know that it will be overlooked, but it may be—that the intention of drawing up these resolutions was that they might be presented to the American Railway Association.

THE PRESIDENT: Mr. Sinclair, do you desire to include that in your motion?

MR. SINCLAIR: I do.

THE PRESIDENT: Then the motion as it stands is that the resolutions as a whole be adopted as the sense of this Association, and that copies of the same be referred to the American Railway Association showing the action taken.

The motion was carried.

THE PRESIDENT: What is your pleasure in regard to the continuance of the committee? I judge from the remarks of Mr. Quereau that there is still further work ahead along on this line.

Mr. Quereau: This committee has worked for three or four years on this subject. The matter has been brought to a fitting end apparently, at least so far as the ideas of the committee are concerned. Barring some details, I do not see any reason for a continuance of the committee. There is one matter which ought to be given to a committee. I think the present committee could just as well be discontinued. The point I refer to, to consider which a committee might be appointed, is to determine what is the proper credit of ton-mileage for switch locomotives. This committee has not covered that point, but it should be covered in order to make the resolutions effective and complete. I think the present committee has done enough.

Mr. Symington: I certainly think that no other body of men in this Association are as competent to draw up a report upon that subject as the committee which has presented the report which we now have, and I think they will be willing to wind up their work by giving us the result of their experience in investigating the matter further to reach a solution of this particular point, and I move that the same committee be requested to report on this particular proposition next year.

Mr. L. R. Pomeroy: I offer an amendment to Mr. Symington's motion, that the committee be continued and that the committee be given power to present these resolutions to the American Railway Association. It was moved to present them, but no method was adopted.

The President: That can hardly come in as an amendment to Mr. Symington's motion, but can be made a separate resolution.

Mr. Pomeroy: I move that the power be given.

The President: The Secretary has been authorized by a previous vote to present the resolutions to the American Railway Association. A motion has been made and seconded that the committee be continued to report on the subject in regard to credit for switching mileage, and any other subjects pertinent to the general question which may occur to the committee.

The motion was carried.

The President: The next report to be considered is the

"Relative Cost of Running Trains of Slow and Fast Speed." Mr. Wm. McIntosh is chairman.

MR. MCINTOSH: Prof. Goss has kindly consented to read the paper.

Prof. Goss read the following paper:

REPORT OF COMMITTEE ON RELATIVE COST OF RUNNING TRAINS OF SLOW AND FAST SPEED.

To the President and Members of the
American Railway Master Mechanics' Association:

Your committee above named would report that various circumstances have served to prevent it from submitting an elaborate report at this time. Chief among these is a feeling that the whole question is one of many variables, and that it is properly much more an operating question than one affecting the design of equipment. The committee feels, moreover, that the excellent work accomplished by its predecessors in office, and especially the results reported last year by Mr. Delano, are indicative of the general results which would be obtained in any investigation, however extensive. These considerations, coupled with the fact that all members of the committee have been much engrossed with the routine business of the year, have resulted in nothing being done excepting by our chairman, whose account of an interesting test the remaining members of your committee are glad to have submitted as an appendix to this report.

WM. MCINTOSH,
J. F. DEEMS,
GEO. F. WILSON,
W. F. M. GOSS,
Committee.

APPENDIX.

As pointed out in the report of 1901, there is very little reliable data on this subject, and really no means of obtaining it aside from special tests like those made by Mr. Delano in 1900.

The chairman of this committee was of the opinion that some interesting comparisons would result from moving a train of a given weight over a certain distance at both fast and slow speed by the same locomotive, and accordingly arranged to run such a train between Jersey City and Somerville, N. J., over the C. R. R. of N. J., a distance of thirty-seven miles and return. These runs were made in June, 1901, between 10 A. M. and 4 P. M., under substantially uniform conditions of weather. The engine was of the "Atlantic Type," having a boiler with Wootten firebox,

may see fit in regard to the experiments and tests made on his road.

MR. MCINTOSH: There is very little to be said aside from what is contained in the appendix. As is pointed out, it is a very difficult matter to make tests of this kind within the limitations of ordinary service. In our attempt to bring out some data based on this test, we were disappointed in many ways. As stated in the report, it is more interesting in illustrating the difficulties than instructive in its results. The additional cost of operating the high speed train, however, is clearly demonstrated.

PROF. GOSS: It seems to me that if the consideration of this question be narrowed to the locomotive and if it be made simply one of determining how much fuel is required to do work at different speeds, that we are reasonably safe in depending on the results presented by Mr. Delano in the report of last year, which, as I interpret them, are confirmed by those presented this year by Mr. McIntosh. Assuming the locomotive to be well adapted to the service required of it, if we base comparisons upon time, we shall find that the increase of power and consequently the increase of fuel, is practically proportional to the increase of speed. If we base comparisons upon distance traversed, we shall find that the coal required is practically the same for high speed as for low speed; this statement applying within such limits of speed as are now common.

MR. L. R. POMEROY: Among the figures presented in Mr. Delano's report were some figures of actual tests made by Mr. Bush on the C. M. & St. Paul Railway, where the principal increase in cost was mainly due to fuel consumption; and as the average cost in this country is one dollar per train-mile, an increase of even 50 per cent in coal consumption would be rather insignificant, as the cost of fuel is only 8 per cent of the total cost of operating a train one mile.

MR. R. D. SMITH: The committee has quoted Mr. Delano, and several gentlemen have also mentioned the remarks made by Mr. Delano last year. I understood from Mr. F. H. Clark this morning, that it was expected Mr. Delano would send a communication on this subject, but it has not been received up to the present time. I thought perhaps the members of the Association

might like to know what Mr. Delano has to say on the subject, and if they will defer action on the matter until to-morrow, I hope to have such a communication here. Mr. Clark left the meeting room to see if the letter from Mr. Delano arrived by the second mail this morning, but as he has not returned and the discussion on the subject is approaching a close, I suggest that further action on the topic be postponed until to-morrow.

MR. ANGUS SINCLAIR: I move that the discussion be delayed until to-morrow.

The motion was carried.

THE PRESIDENT: The reports provided for to-day's session have been presented, and as we have some twenty minutes before the time for topical discussion, it would seem wise to take up one of the papers on the program for to-morrow, as we shall have a short session to-morrow.

If there is no objection, we will proceed on that basis, and take up the individual paper by Mr. C. A. Seley entitled, "Electric Driving for Shops."

Mr. Seley read the following paper:

ELECTRIC DRIVING FOR SHOPS.

BY C. A. SELEY, CHICAGO, ILL.

(Formerly Mechanical Engineer, Norfolk & Western Railway.)

(A Member of the Association.)

To the President and Members of the
American Railway Master Mechanics' Association:

The subject of electric driving for shops is a very broad and comprehensive one. The general principles governing this mode of transmission of power have been so well covered by a committee report presented to this Association in 1900 and in recent papers in other associations, as well as in contemporaneous literature, that an invitation from your Executive Committee to present a paper on the subject was somewhat of an embarrassment. The development of the art, however, shows such advances and new opportunities that I may not be amiss in feeling that this Association may be interested in knowing of what were the considerations and ruling factors in the design of one specific example and the application thereto of the principles laid down by your former committee, rather than in a repetition of a general paper on the subject.

We can not, as a rule, have new shops to lay out exactly to meet our economic needs in railway equipment building and repair work. Some

whereby the correctness of the theories of its design and arrangement might be shown. An unfortunate delay in the delivery of some of the machinery has prevented the starting up of the plant, so that this data is not available at the time of writing. The original paper, therefore, has been revised, and the views presented are open to challenge and debate until they can be proven by the operation and tests of the plant referred to.

In order to give a definite idea of the size of Roanoke shops to those who have not seen them, it may be stated that they take care of the medium and heavy repairs of nearly five hundred locomotives, mainly of the consolidation type, build complete one 21 by 30 consolidation engine per month, and of cars about one thousand per year. Add to this the freight repair work of sixteen hundred freight cars per month, the entire passenger equipment, heavy repairs and considerable building of new passenger equipment, miscellaneous road work, switches, water station and coal pier work, etc., of a 1,600-mile road. Include also a foundry whose record for 1901 was as follows: 950,000 pounds of brass and phosphor-bronze castings, 44,000 pounds of white metal, 5,385 tons of gray iron castings, and 43,000 car wheels.

The various power plants at these shops in June, 1901, were as follows:

Power plants N. & W. R'y shops Roanoke, Va

SHOP.	BOILERS. Nom. Rating.	ENGINES. Nom. Rating.
Machine shop	270	200
Electric plant		170
Smith shop		
Smith shop aux.	60	
Smith shop aux. furnaces	90	
Flue shop and blowers		
Bolt shop		
Toolroom		
Testroom		
St. Dr. air compressor		
Erecting and boiler shop	90	30
Erecting and boiler shop		30
St. Dr. air compressor		
Foundry	60	40
Pattern shop		
Planing mill	260	225
St. Dr. air compressor		
Frog and switch shop	50	30
Rail saw mill		50
Dry kiln		

From this table it will be noted that there were two principal power plants, one in the machine shop which furnished power to a number of shops, and one in the planing mill whose boilers furnished steam for

various purposes. Besides these, there were five auxiliary plants of boilers or engines, or both, making a sum total of 880 nominal horse-power of boilers and 775 nominal horse-power of engines for shop power, heating and lighting, the latter service extending beyond the shop's inclosure and furnishing all-night and such day lighting as was required for lighting general offices, hotel, depots and yards.

Thus it will be seen that a varied, scattered power service had been built up, and to take its place a new plan must be made which should take into consideration the concentration so far as possible into a central power station such an amount of power as would do away with all auxiliaries, thereby securing economy of fuel in generating steam, economy of handling of fuel and ashes, in operating force and expense for supplies and repairs. In this plant the change had to be made without interference with the operation of the shops or lighting plant.

A careful study of the situation developed the following plan: To provide a new boiler plant capable of developing steam for all power needed save and except only such as could easily and with certainty be made by refuse from the planing mill with practically no extra cost of handling, the object being rather to utilize a means, without wasting it, of burning refuse.

ller plant. In large electric installations the center of electrical distribution is an important point to find, and the generating plant should be placed near thereto. In shop plants this is not always the ruling factor and it may pay to use a little more copper and place the plant where other considerations are of more importance. In this case the utilization of a large brick stack of sufficient capacity and the location of an elevated trestle for directly dumping hopper cars of coal indicated the location of the new boilerhouse, which was planned for the immediate installation of 600 nominal horse-power of boilers and reserve for 400 horse-power additional. In a more northerly location additional boiler capacity would be needful in winter for an establishment of this size.

These boilers are in 200 horse-power units, it being believed that smaller units do not give a like economy and that it would not be wise to have less than a two-thirds capacity to fall back on in case of the failure of any one boiler. It is deemed unnecessary to go into detail as to the boiler arrangement, stack and smoke connection; their general arrangement is shown on the plan of the works herewith. The boilers have been installed and connected to the old system of steam piping, and have been operating for some months in a very satisfactory manner, and some considerable economy of fuel and maintenance has been secured thereby.

The direct current system of electric transmission of power and lighting was adopted, using two-wire, 220-volt current for motors and three-wire system for lights. This was determined upon after visiting a large number of plants.

Instead of preparing a set of specifications requiring a definite arrangement of the electrical machinery, it was thought best to issue an invitation

to the electrical companies to tender on such forms of apparatus as in their opinion would best suit our needs, these needs being fully set forth for their information.

The instructions relative to the general layout read as follows: "There are to be three generators, each direct driven by a compound, non-condensing engine. Inasmuch as two voltages are desired, namely, 110-volts, three-wire system for lighting, and 220-volts for power circuits, the arrangement and design of these generators may be proposed in more than one form, to permit delivery of current from the switchboard of either power or lighting voltage from any combination of the generators." A schedule of the power and lights probably required was then given, covering the twenty-four hours. The instructions then proceed: "All generators must be of the latest and most improved type. They must be guaranteed by their makers to develop electrical energy specified, and the guarantee should state the electrical efficiency and also the limit of heating with the rated load."

The system of shop lighting has been series, constant current, double carbon, open arc lamps for general illumination and 110-volt incandescent lamps on alternating circuits. The new system puts the power and lights on the same current, using more than one unit for generating, lessening thereby the probability of a breakdown affecting the continuity of service.

Use of direc current sys of electricit approved.

Direct-current machinery was chosen on account of its applicability to all the classes of service required, and for three principal reasons: First, for use in crane service, as being best adapted to that work. Second, by reason of the slower speeds of direct-current motors, they are more readily directly belted to line shafts and machines without the use of intermediate countershafting. Third, alternating-current motors are very enticing on account of their simplicity and ease of repair, and I have no doubt that their makers and users have very convincing arguments for their adoption and use; they are, however, far more expensive per horsepower than direct-current motors. Great care has to be taken in wiring for the alternating-current systems to avoid trouble and losses from induction and cross currents. No trouble of this kind is experienced with the direct current if care is taken to properly proportion the wires for their load and the ordinary precautions in regard to insulation are followed. The alternating current certainly has its field in long-distance transmission, where a cheap source of power can be reached and by high voltage be economically transmitted. In such a case the final voltage and its mode of distribution must be determined by local conditions and with special reference to the work to be done.

There were, therefore, electrical, mechanical and financial reasons that determined the use of direct-current transmission in the shops I have named. The plan of the work shows that the power station is by no means the center of distribution, the greatest radius being about 2,000 feet, and it required a 700,000 C. M. cable to transmit the power necessary at the

mill. The investment in such a cable, however, was far less than it would have been to install the powerhouse at an intermediate point so as to reduce this radius and the weight of the copper required.

The bidders were requested to fulfill the following conditions in their tenders on the switchboard: "The switchboard to be of marble, provided with one ammeter and one voltmeter for each generator; two recording wattmeters (one for each side of the three-wire circuits); one recording wattmeter for power circuits. To have also automatic cut-outs for guarding against overloads; lightning arrestors, and the necessary fuses. Triple bus-bars are to be provided for light circuits and double bars for power circuits, and suitable switches are to be provided to throw the current from any generator to either the lighting or power circuits, and in addition to these there should be a main switch for throwing the two sets of bus-bars together. Contractors are requested to furnish a design of switchboard embodying these features and in addition such feeder panels and switches as seem necessary to operate the plant, taking into consideration the plan of the works and the distribution of power and lights as stated.

"It is desired that the switchboard be of neat design, with all instruments, switches and other attachments first-class in every respect. It is desired to incur no unnecessary expense in elaboration, but to provide every facility for convenient operation, safety and accurate electrical measurements and records. The wiring between the generators and switchboards to be of heavy copper, braided, rubber-covered cable run below the floor in conduits."

A complete plan of the works and yards and the probable amounts of light and power for each location were furnished bidders upon which to base their recommendations and proposals.

nerators.

The plan finally adopted comprised three generators, one 75-K. W. and two of 160-K. W. each. The smaller unit being approximately 100 horse-power and the larger ones something over 200 horse-power each, it will be seen that by combinations of the generators, 100, 200, 300, 400 or 500 horse-power may be transmitted to the board. This is believed to be good steam engineering, as it affords an opportunity to work the engines closely within their most economical range of steam using.

ghting.

The three-wire system of lighting generally requires two generators to be worked in series, but in this plant, for considerations of simplicity, first cost and general convenience, and for the further reason that the plant is primarily a power plant, the arrangement and voltage of the generators were fixed with a view to all these considerations and operated direct to the board at 220 volts. This being also the proper voltage for the outside wires of the three-wire system the means of maintaining proper balance between the two sides was then considered and arranged by using a motor-generator balancer set of 10-K. W. capacity. This machine has its controlling switches on a panel of the switchboard and in a simple manner maintains the balance of the two sides, correcting any

inequality of current pressure there may be, due to one side being more heavily loaded than the other.

If the plant was primarily for lights, this plan would not have been adopted, as in that case 110-volt generators, in multiple for lights and series for power, as in the Chicago & North-Western power plant, would be advisable. Care being taken in the distribution of the lights on the circuits, the balancer has little to do and is a simple and effective device. The shops are to a considerable extent wired and equipped with incandescent circuits, 110 volts, alternating current, and it is only necessary to straighten out and extend the service, transferring the feeders to the new switchboard.

General inside illumination is provided for by the use of 110-volt inclosed arc lamps on the same circuit as the incandescent lamps, the arc lamps having opalescent single globes and sheet-iron shades painted white. It is believed that this style of arc lamp is best suited for shop-lighting as against the use of double-glass globes with no shades. The shades distribute downward a portion of the light that would be otherwise wasted upward and do not interfere with the lateral distribution of the light.

The question how far individual motor driving should be considered for machines is an interesting one, but it is the belief of the writer that it is not necessary or advisable to consider anything but group driving in the average railroad shop.

Group drivin

There is one shop that has been considerably exploited by the consulting electrical engineer who laid it out, that is a shining example of the extreme in individual motor-driving. The published descriptions of this shop state that motors of the following horse-powers are installed, as follows: 1, 2, 3, 3.5, 4, 5, 6, 7.5, 8, 9.5, 10, 13, 15, 17.5, 20, 22.5, 25, 35 and 45 horse-power. There are 94 machines listed, excluding cranes, turntables, etc., driven by 68 motors. The machine shop shows 42 machines driven by 29 motors. The arrangement is such that if another machine were to be put in, a motor for it would be required. In the Norfolk & Western machine shop there are 133 machines, which will be group-driven by six motors, aggregating not over 100 horse-power.

A machine may be added to any group without seriously overloading the motor, and as there are several groups we may add a number of machines without change of motors. The additional load would be shown at the switchboard, but by reason of the group system it would add but a small amount to any one motor.

The reasoning in favor of group-driving of railway shop machinery is on this wise: One machine requiring 1 horse-power may be taken as a unit; individually motor-driven, this machine would take a 1 horse-power motor to operate it, even if it ran but one-half the time, and average machine tools are idle or running light at least that amount for work or tool adjustment. Two or three such tools grouped would not require their full multiple of the unit power, but the full value of grouped driving

will be reached (first), when the number of machines in the group will enable the use of a motor of sufficient size for a near approach to good electrical efficiency, which is not possible with small motors; and (second), when the number of machines is such that the proportion of idle time may be so distributed over them as to be practically continuous and effect a proportionate reduction in the power needed in the motor. For example, if one unit takes 1 horse-power and is idle one-half the time, two such units can be driven by a 1 horse-power motor, provided the machines are run alternately, but if both are operated together the motor will be subjected to one hundred per cent overload. If we take ten such units, however, and use a 5 horse-power motor, the chances are about even that the motor will be driven to its rating, and they are infinitely small as to its ever getting one hundred per cent overload. There is no argument against individual motor driving in case the machines to be driven are large enough or if their isolation is necessary to facilitate movement of material, but we are considering average railway shop machinery, and in most cases, old machinery already group-driven from shafting.

The extremist in electric driving does not like to use shafting, but as against an almost one hundred per cent increase of total motor capacity required, the low electrical efficiency of small motors and also the high cost per horse-power for small motors as compared with those of moderate size and power, a reasonable length of shafting will in the end prove the best investment for our class of work. In a wood planing mill the case is somewhat different. The power required is so much greater for heavy planers, and other continuously operated machines, that individual driving may be attempted, but even here it may profitably be limited. Saws, shapers, jointers, mortisers, tenoners, band saws, borers, all intermittently operated machines, can be successfully grouped and driven with a fraction of the power required for individual driving.

orse-power quired.

From the table it will be noted that the mill was equipped with a large engine. An indicator test showed that the average power required, including all friction, to be 160 horse-power, although for short intervals it ran a little over 200 horse-power. It was believed that, by the elimination of the engine friction, the heavy transmission belts, and certain unused lengths of shafting, that 125 horse-power of motors would operate the mill, using seven motors driving forty machines, all on the group system. It was decided that it would be wise, however, to overrun the calculated power at the heavy end of the shop somewhat and 140 horse-power of motors were ordered.

Other departments that are to be motor-driven in groups are the smith shop, bolt and forging machinery; the forge blowers, together with the flue shop machinery; the bolt and nut cutting machinery, together with the smith shop punching and shearing machinery; boiler shop machinery; the foundry rattlers, grinders and drilling machinery in two groups, and the foundry cupola blowers are also to be driven with a motor with rheostatic control for varying the speed according to the need for blast. In

all twenty-three motors were ordered, as follows: Three 7.5 horse-power, five 10 horse-power, three 15 horse-power, ten 20 horse-power, one 30 horse-power, one 35 horse-power, aggregating 382.5 horse-power. It will be noted that the 20 horse-power motor is ordered in a larger quantity than any other size, it being intended that this should be the standard motor so far as possible. All motors are of the regular commercial type, standard with the manufacturers.

The above described motors are in all cases to be directly belted to line shafting. The writer has seen motors directly attached on the end of line shafting, as at the General Electric Company's shops at Schenectady. At another shop back-geared motors were used directly attached, but the gearing was very noisy and neither of these plans employ strictly standard motors.

At the Baldwin Locomotive Works, where both individual and grouped driving are very extensively used, belts are used to the greatest possible extent and in many cases with such short belt centers as to be surprising that good results could be obtained. It was explained that this method was very satisfactory and that after a belt was taken up a few times, in most cases it would run thereafter almost indefinitely, and if it did fail, its replacement was much easier, cheaper and speedier than to repair broken gearing.

Connections between motors and machines.

On the other hand, many shops employ gear connections between their motors and machines, especially the modern heavy machinery, much of which is now built to be directly driven. Where the gearing can be covered and protected it may do very well, but wear is inevitable and gear breakages are expensive and at times exceedingly inconvenient. There is a very desirable flexibility in a belt connection and if there should be a failure of the motor an extra one can be readily installed if standard types are employed. Some of the electrical companies have developed systems of multiple voltage, which, in connection with double or triple gearing, give a large range of adjustment of cutting speed of tools individually driven, enabling maximum output after proper speed has been determined by experiment. These systems involve the use of considerable gearing, additional wiring and a generating set arranged with reference to the number of the voltages desired. Some of our friends who have installed multiple voltage may be able to enlighten us as to its advantages, but as the writer does not favor individual driving as a rule, multiple voltage was not considered in connection with the plant under discussion.

The description so far has reference only to the regular motors for power purposes to be used at Roanoke shops. In addition to these, various situations have been considered and electrical power planned. Some of these are as follows: The substitution of a motor instead of a rope drive for the machine shop walking crane which operates on a center track running the length of the machine shop and serving heavy tools adjacent thereto. A railway motor and controller is to displace a steam engine and boiler driving a turn-table. A new 40-ton, 3-motor crane with a 5-ton auxiliary hoist

was installed in the erecting shop, and a 25-ton rope-driven crane is to be reënforced to carry 40 tons and be electrically equipped in a similar manner to the preceding crane for use in the erecting and boiler shops. A rebuilt crane of 15 tons capacity is to be installed in the foundry, displacing a hydraulic crane which could operate over but a small area, while the traveling crane could cover a large portion of the foundry floor. It is probable that in the near future a second turn-table, now hand operated, will be electrically operated, and that electrical power will be furnished the general office for elevator service.

Cranes.

THE PRESIDENT: Gentlemen, you have heard this valuable paper presented by Mr. Seley. What is your pleasure?

PROF. HIBBARD: I move that it be received and opened for discussion.

The motion was carried.

THE PRESIDENT: The paper is before you. As a good many roads have been looking into electrical power plants, I hope the discussion will be general and of interest.

MR. GEORGE L. FOWLER: This matter of electric driving of shops has been brought up frequently, but there is one point which I do not notice touched upon in the paper, which is all-important, and that is the question of economy. Certain tests have been made in cotton mills and machine shops where it has been possible to make a comparison between the cost of driving by electricity and with the ordinary shaft methods. In both cases where such comparisons have been possible, it has been found there is but little difference, and what difference there is is in favor of the shafting; that is, if it is a shop where all of the machines can be considered as one unit and are driven from a line of shafting, it is cheaper to belt all the machines directly to the shafting than it is to put in an electric drive either in large or small units; but that is a comparatively insignificant factor in the total of shop expenses, while if the other savings which come in from the use of electric driving are taken into consideration, there can be no doubt whatever as to the favor that would be shown to the electric method. For example, you put in a line of shafting, with the countershafting, and the whole ceiling is occupied, leaving no room for hoist or traveling cranes, and the expense of handling material in and out of the shops is increased

over what it would be with electric driving, where you would have the facilities for putting these helps in.

In one shop with which I am familiar—a boiler shop—they found that the saving in labor was about six times the extra expense of using the electric drive. That, I think, would be the experience in any machine shop where it is necessary to handle work in and out of tools very frequently, which is one of the great arguments in favor of the use of electric driving. In such a case as the repair shop and any other railroad shop where power must be distributed over wide areas and you want individual units for various departments, one central plant distributing the power to all points is, of course, much more economical than using independent engines with their independent attendants scattered over the premises, and even for the simple case where one shop is standing by itself and is using one source of power, the saving effected by the handling of material is much greater than the extra expense of the use of electric motors as compared with steam engines. These are the general reasons for the advocacy of electric driving in most of the railroad shops of the country, and more particularly in the case of new plants.

MR. R. V. WRIGHT: In designing our shops, which we are about to build at McKee's Rocks, we have studied the power question thoroughly and have practically decided to use, to at least a large extent, the individual system. There are a number of reasons why we have done this, but I will only touch upon two of them. We find that we can get a clear headroom so that material can easily be handled by cranes, and we expect to make quite a saving by the use of variable speed motors. With our machines as designed now, the steps between the different speeds are quite large. With the use of a variable speed motor, we can make the differences much smaller in stepping from one speed to another. For instance, not very long ago our master mechanic in going through the shop found that in turning down a crank pin the speed seemed to be altogether too slow. He stopped at the machine and instructed the man running it to throw on the belt a step higher. The man did so and burned his tool right off. Now it was perfectly evident that the machine was running too slow, but we could not speed it any higher, because the next step was

so great that it made it too high. With a variable speed motor you can make a smaller step, and the man can get just about the speed which the tool will carry. In this way we greatly increase the capacity of the machine, we get much more work out of the man, and we feel we can turn out a great deal more work in our shop with the same number of machines than we can by the present method.

Mr. Angus Sinclair: Mr. President, I know very little about electrical machinery for driving machine tools; but I have been interesting myself in the subject to some extent as it has been developed, and have been struck with the advantages we get from the individual drive. I merely get up to state an incident in connection with that. I was out West and talked to a master mechanic who is building new shops and who was about to introduce electrical power for driving machinery. I expressed the belief that the individual method was better than grouping, but he favored the idea of grouping and argued in favor of it. He said, however, that he had not positively made up his mind which was best, but that he was coming East and he intended to visit a number of shops and see which was the most satisfactory. He came into my office about a month afterwards, and, of course, I wanted to hear the news of the day from him. He said he had gone into a shop (he mentioned a well-known tool manufacturer) and that they were using the group system. He went along with the foreman to see how the work was going on. The foreman expressed the opinion that the group system was all right, that it was better than the individual system, and there were fewer motors to look after. They went along to a place where there were five machines standing idle, and he found an accident had happened to the motor that was driving that group and the men were all standing idle waiting for the motor to be repaired. Now, that was what I call an object lesson, and illustrates the advantage of individual motors.

Mr. George W. West: I would ask Mr. Wright whether they considered steam driven tools in comparison with electric driven tools, and what the first cost of the two systems would be.

Mr. Wright: When we first started to work on the plant, the question was taken up as between steam power and electric

power and we decided to use the electric power after going into the matter very closely. We first decided to use the group system entirely, but when the advantages of the variable speed individual motors were called to our attention, while at first we were very skeptical on the subject, we were finally led to believe it would be to our advantage to use them.

MR. WEST: I do not think Mr. Wright understood me about considering the cost of steam driven tools—the relative cost between driving your tools by electric power and by steam power. Did you take those matters into consideration?

MR. WRIGHT: In the first place we did, and decided in favor of electric driven machinery.

MR. WEST: As a matter of economy?

MR. WRIGHT: Yes. I would say further, that we have several shops that will require power, and the power must be transmitted from one central station, and for that reason we found it was advisable to use electric power.

THE PRESIDENT: In the report presented, it has been suggested that there are two methods of utilizing electric power, the direct current and the alternating current systems.

There may be some members present who have had experience with both methods and who can give us information as to their comparative economy. Mr. Seley presents his report in favor of the direct current system and it would be interesting to hear from those who have given thought to the other side of the question.

MR. T. R. BROWNE: I have no actual figures of economy at hand, but it may be interesting to tell the members here that the works of the Westinghouse Air Brake Company are equipped entirely with the two-phase, alternating current type of motor, which you probably know is an induction motor. We have in the neighborhood of two thousand machines at the present time and the group system, as far as the machine shop is concerned, except in the case of one tool, and that is a recent acquisition. The capacity of the motors driving machine groups runs from twenty-five to thirty horse-power and the number of machines per motor will vary from fifty to one hundred, according to the size.

Most of the work is sufficiently light to handle easily without using hoists, and the total number of motors in the plant is taken

care of by two men. The only attention which the motors require is the cleaning out of the bearings and oiling, which is done at intervals of two weeks. The point has been raised that if one source of power supplies one hundred or one hundred and fifty machines, in circuit, and any accident happens, all these machines have to stand still until the defect is remedied. I will say that covering a period of a year and a half, I do not believe that motors on the main operating floors have been idle a total time of two days. The simplicity of the motor, the ease with which it is started, and the amount of overload it will stand, is very much in favor of this type of motor for the purpose for which we are using it. There is an excellent installation or application of both systems, the grouping and the direct driven, at the Westinghouse Electric & Mfg. Company's Works at East Pittsburg.

MR. QUEREAU: I do not profess to be an expert in this matter at all, and only wish to call attention to one or two items. It occurs to me that the conditions in a manufacturing plant, as to the advantages of one system over the other, the individual over the group driven machines, might be quite different when compared to the work in the repair shop of a railroad company. The variations in speed on a given machine are liable to be greater in a repair shop than in a manufacturing plant, where the tools are commonly put on one class of work and the speed for that class of work having been determined, it is practically constant. In a repair plant, as we all know, the character of work, the size of work and the speed at which it is to be driven, varies a great deal. I may say that I have been much interested in Mr. Seley's paper, and to me, at least, it has been very valuable and helpful.

There is one feature of it on which no particular emphasis is laid, and yet it is one which I think is well worth considering, and that is whether the power should be delivered by belt or by gearing in the place of individual or small group driven machines? I have in mind a plant built within the last year and a half or two years, where gearing is used as the means of delivering the power of the motor to the machine. I am told that for a considerable period, and even up to the present day, it is very difficult for the foreman to convey his orders intelligently to the men at the machines, and that communication across the shop is prac-

tically impossible on account of the excessive noise. A part of this has been attributed to the fact that the gearing was cast steel; some one said it was not machined, and some one else said it was not properly machined, but it occurs to me that is one feature which should be taken into consideration in determining how power should be delivered to a machine.

Within the last few months I went through a shop largely electrically driven, where the motors are attached to the machines by means of belting, and in many cases the belting is quite short. In addition to the advantage of decidedly less noise produced by the belting, there is another advantage, in that the breaking of the gearing on the machines is much less where the motor is attached to the machines by means of a belt. In the shop to which I am now alluding, originally a number of machines were driven by gearing, and in starting the machine they found that many of the wheels were broken. The belt gives an elastic means of communicating power not possessed by the gearing, so that while I have not any settled opinion on the matter, I am inclined to believe that the belting means of conveying power is preferable.

MR. GEORGE W. WEST: I would ask some of the gentlemen who have had more experience in electrical driving machinery, how they rate their motors? The road with which I am connected was unfortunate in having a planing mill burned a year and a half ago, and when we remodeled the shops we decided we would drive a portion of the machinery by electric motors. I do not remember the capacity of the engine we formerly used to operate the machinery in the planing mill; but I know we decided on using one-half of its horse-power in driving about one-quarter of the machinery by electricity. Included in that machinery was our planer for dressing sills, and notwithstanding we had given about one-half of our engine capacity to this one-quarter of the machinery, we found it was impossible to operate the machinery. In starting the planer we would invariably burn out the motor. If the ratio had been carried out over the entire plant, we would have had to purchase electrical machinery four times the rated horse-power of the steam driven machinery. That was my object in asking Mr. Wright about the relative cost of the two systems. In other words, if we are obliged to purchase four hundred horse-

power of electric motors to do what we can do with one hundred horse-power steam driven machinery, where does the economy come in?

MR. SYMINGTON: I think the point just raised is not a question between steam driven machinery and electrically driven machinery, but a question of grouping or individual machines. If you divide up your steam engines around your shop, I think you would find about the same proportion of increase of horse-power with the steam machinery as with the electrical machinery. It is a well-known fact that a planer consumes a great deal of power; where the whole shop is run by one engine, that one engine can meet a heavy demand made on it by one machine, without serious detriment to another machine. This is entirely a question of individual operation of the machines or of running them all from one engine.

MR. WRIGHT: I think I misunderstood Mr. West's question. The first cost will certainly be more for electrical than for steam driven machinery. Undoubtedly that is so; but the advantages to be gained and the saving to be made by electrical machinery are such that we feel it is a good and paying investment.

MR. WEST: It pays the interest on the additional cost?

MR. WRIGHT: Yes, sir.

MR. GEORGE L. FOWLER: In regard to what Mr. West said, corroborated by Mr. Symington, a power plant which I happen to know of, operated in New York—I think it is one of the first electrical distributing plants in the city—put in a 75-horse-power engine, run the dynamos, took the losses on the dynamos and then distributed the current to the motors and rented 150 horse-power out of these motors, and received the rental for years, without any complaint on the part of the people who were paying for the 150 horse-power, realizing that the engine that supplied the power was rated at 75 horse-power and that the output was probably 65 or 70 per cent of that. The reason that this was possible was because all of the shops were not driven to full capacity all of the time. Each shop was driven by a motor capable of doing all the work in the shop, but was never called upon to do it together with all the rest of the motors. The result was there was an elasticity of distribution, so that when one shop was making a full

demand on the service some other shop was letting up. The same way with Mr. West's shop; when the planer was at work, the demand for power by the planer was too great, probably because many other machines were in operation. In the group driving or individual driving you must put in a motor that is strong enough to do all the work all the time for which it is rated; whereas in the engine room you can have a flexibility of adjustment in the distribution of the power by which an excessive demand at one point is compensated for by a falling off in the requirements at others. But at the motor, where the driving is practically at the machine, there you must have one the capacity of which is up to the full requirements of all of the tools when working together.

MR. WEST: What would be the result if the tools took all the horse-power, and you should put all the tools in operation at one time? That is the condition we have to meet in railroad shop work.

MR. FOWLER: Of course, there would be a general shutting down, accompanied by a general "kick." (Laughter.)

THE PRESIDENT: One of the questions which comes up now in the design of shops to be equipped with electric power seems to be as to the direct or induction current motors and the voltage; considerations, no doubt, that some of those present have given thought to; and I would like very much to have some one address the meeting who is an advocate of or who has had some experience in, or given some thought to, the comparative merits of the two systems as applied to railroad shops, instead of having it as it is now, with only one side.

L. R. POMEROY: The paper presented by Mr. Seley, as I understand it, is not the discussion of the advantages of electricity in a railway shop *per se,* but is the description of the adaptation of electric drives to an old shop where the shafting and belting are already in place, and such installation planned to make as slight a departure from past arrangements as possible; also one involving but little discarding of old material, and the electric units so distributed as to bring down the first cost as low as possible; thus the group driving is used throughout the shop. There is an incidental advantage to group driving due to being able to take advantage of the stored energy in fly-wheels and shafting, in help-

ing out the starting torque for tools especially with reference to drills and similar tools.

In the case before us the first great advantage then, is that due to concentration of the different power plants in use under the old conditions into one large power house unit, the advantage of which proceeding is obvious. Generally the first rudimentary steps in installing electric drives is to apply the electricity in such a manner as the method of operating the shop is as near as possible to the old methods with which the men are acquainted, which generally means group driving; but the history of other shops—and I prophesy that it will be of this shop also—is that as soon as the advantages of electricity begin to be known and its flexibility and adaptability are realized, the individual motor application will begin to come, and in time the individual part will be greater than the group.

There is one point which on general principles seems questionable, namely, the employment of group driving in a wood shop; but as I understand the situation, the shop Mr. Seley describes lies among the exceptions, as it seemed the advantages of utilizing the shafting and pulleys already in place were greater, for this particular case, than were apparent with individual drives.

Generally speaking, the greatest advantage to be derived from the employment of electricity in shop driving is realized in a new shop. There is no discarding of material, a saving can be made in cost of roof structure, and provisions made for traveling cranes, as it is not necessary to support main shafting from the roof structure; besides an arrangement of tools with reference to the work to be performed, and not dependent upon line shafts or mechanical means of transmitting power to tools.

There is also the question of dividing up tools into classes,—intermittent and constant driven tools. All these elements enter into the question whether the tools shall be group driven or how many of them shall be individually driven.

Relative to the case Mr. West cites, I cannot quite understand the situation described. I do not understand whether it was the generator or the motor that burned out.

Mr. West: It was the motor.

Mr. Pomeroy: It looks to me as if the motor was too small. We have numerous instances where the generators are belted from the main shaft and even utilizing only a part of the total power of the engine, and giving satisfactory service and no trouble on this account. As to the point raised by Mr. Fowler concerning the average draft on the generators, one of the best evidences of this is found in a locomotive shop where 3,500 horse-power in motors is installed, and never at any one time is there shown more than 1,000 horse-power at the switchboard.

The President: Mr. Van Alstine, I believe in your Oelwein shops you have your tools driven by electrical power. I think it might be of interest to the members to have an outline of the system as to the good or bad features that may have developed.

Mr. Van Alstine: I do not believe I can give any information which would be of great value. Our plant is the direct system, consists of three 100-K.W. generators and we are running practically up to the limit of the nominal rating now. One thing we found, and that is that while originally the plant was designed with a good deal of care, the distribution of the motors was far from correct; in other words, we found that some of the motors were considerably underloaded and others were considerably overloaded. We have had a readjustment of all this. We have no very accurate figures as to the cost, but we find in our particular shop the direct current system is very satisfactory. We have a building well fitted to that system. It seems to me there is a good deal lacking as regards definite information as to the cost of the direct current system and the alternating current system. I believe there are a good many shops, notably one I have in mind on the Pennsylvania railroad that keeps an accurate daily log. It occurs to me it might not be a bad plan if we had a committee appointed for another year to get together such information. I believe there is a good deal of it that could be obtained if it was gone after.

Mr. William McIntosh: The road I am connected with has recently built large shops and the machinery is driven by electricity entirely. We have not confined ourselves to either the individual or the grouping system, but have used them both. In some places we find it is of advantage to drive our machines in

groups. For instance, the bolt lathes, brass department machinery and tool-room machinery, are driven in groups, while our large tools are driven by individual motors in nearly every case—the heaviest and slow moving machines by gearing and the lighter ones generally by belting. We have endeavored, where we use belts, to obtain a minimum length of eight feet. The system we are using is the direct current. I have no knowledge of the alternating current system in comparison with the direct current system, but we find the latter is very satisfactory. It is a great convenience to drive tools directly. You can locate them where they will render the most efficient service and do away with a great deal of scaffolding and supporting beams that are necessary when you follow the grouping system. We have found, however, that the machine builders have a good deal to learn yet in the way of rigging up their machines to be driven properly by electric motors. Altogether we are very well satisfied with the results obtained.

MR. SELEY: In regard to the general proposition of electricity, taken up in part by Mr. Fowler, I would say it is a matter for each individual to determine whether anything can be gained by having a central station which can economically distribute power from a plant supplying current to separate portions of the works. Where you have an engine directly belted to shafting, also intermediate shafting and belting, there is friction of the engine and main belt, friction of the shafting, and friction of the transmitting belting between the several sections on that shaft. Against that, as an offset, you must put in the friction of the engine driving the generator, loss in generator, losses in the wiring, loss in the motors, and the losses in the connections. If you can figure out a saving in using electricity, it is a credit to that system as a means of transmission; but I think we too often lose sight of the fact that the cost of generating the power, and transmitting it, is a bugbear that is considered more largely than its importance warrants.

Transmission of material, of partly finished and finished product is of prime importance, and overshadows every other consideration. If we can facilitate the movement of material by overhead cranes so as to make a large daily saving in the cost of operating the shop, it is time to consider the facilities for putting in these cranes, and if necessary, cutting down the line shafting

out of the way and driving by individual motors. But each shop must figure on its own basis, and I think that a combination arrangement whereby small tools can be group-driven and large tools and isolated tools driven independently will be the best solution and give the maximum return.

As our chairman has well brought out, the paper is specially written in reference to the old plants. We have lots of old shops in this country—shops which work at a disadvantage in regard to the movement of material primarily and cost of generating power secondarily. Many of these shops can be very materially improved in the cost of production by facilitating the movement of material and decreasing the cost of power by the use of electricity.

In regard to Mr. Sinclair's object lesson, I would say there are two sides to consider in that. The individually driven tool in a machine shop or in a mill, for that matter, requires a small motor, unless we put in motors which are larger than are required, and small motors cost per horse-power very much more than large motors. Naturally, I would not care to give any figures, but any one going into electricity had better become well posted before giving any orders. The individual motor-driven machines require a variety of motors, running from two and three horse-power up, and this variety of motors means a large bill for maintenance, for the repair of parts, etc. The large motor for group-driving can be made a standard motor for a plant to a considerable degree. For instance, in the shop referred to in the paper, the Roanoke shop of the Norfolk & Western Railroad, a twenty horse-power motor was made, as far as possible, the standard motor; and while it is true that there are ten, and fifteen, and twenty-five horse-power motors in that shop, still the twenty horse-power motor was made standard so far as possible, and these motors were ordered in greater number than any other size.

In regard to alternating current systems I will say that I have never seen but one railway shop operated by that system. I refer to the shop at Ft. Wayne. There are conditions at that place which justify the use of the alternating current. As I understand it, they operate over a long, narrow strip of territory, requiring electricity at one point several miles in one direction and at another point several miles in the other direction, and the shops

are located in the middle of the plant. Furthermore, they have no cranes.

I think I touched on this point in my paper as to the desirability of a flexible connection between the motor and the machinery and to provide some other means for this connection than by belting. There are some other methods, I understand, which I have not fully investigated, which are available particularly for short centers.

In regard to Mr. West's motor burning out on his planer I think it is probable that Mr. Pomeroy's explanation is correct. I would say that the extra load on a motor on starting in individual driving, of necessity requires a greater power in the motor than is in use after it is under way. In group driving these variations are taken care of by the group. You will have fluctuations of load above and below the normal rating, but in my argument I have taken the ground that these variations in all probability, if the motor is carefully selected for the group, will not at any time produce an injurious overload.

In regard to Mr. Pomeroy's criticism of the individual motor-driven planer, I wish to call the attention of the convention to the statement in my paper that there are very few machines in a planing mill that have a regular load. They are almost all of an intermittent nature—the saw, the shaper, the borer, almost all of the machines in a mill, except the planers, are intermittently driven, and in direct reference to the mill at Roanoke, I would say there were five cross shafts and two longitudinal shafts, operating on heavy transmission belting, with 225 horse-power engine, about in the middle of the mill at one side, operating at an average of 160 horse-power.

I do not think there is any possibility that we have made any mistake in putting in the motors that we have supplied in that mill considering that we cut out the friction of the 225 horse-power engine, cut out heavy transmission belting connecting up the various lines, one with another, and we will put in sufficient power in the motor for starting the heavy groups without ever burning out the motors. In reference to the rearrangement of the motors on the Chicago Great Western Railway, I think that is a very general experience. In looking up this matter I found there was very little definite information in regard to the power necessary for

driving machinery, either singly or in groups, and it was my intention, had I remained at Roanoke, to put in a testing motor for each situation, and to put in the permanent motor dependent on the result of the test, using a little horse-sense in connection with the whole proposition in regard to the probable necessities of the future.

Concerning the daily log spoken of by Mr. Van Alstine, I would say I have seen a similar log at the Chicago & Northwestern plant in Chicago, which all of you know is quite an extensive plant, and I have no doubt that Mr. Quayle will be glad to furnish any committee of this Association a copy of their daily report which includes the electrical measurements, the coal supplies and other elements of cost.

I would call attention to the fact that the new shop has continually cropped out in this discussion. I do not say that I would use my own arguments altogether in the equipment of a new shop from the ground up, if I were to have new machinery put up in these shops as well as a new power transmission plant. The paper was written more particularly with reference to old shops and for the reason which is plainly stated in the preface to the paper.

Mr. Van Alstine: If I am in order, I would move the appointment of a committee for another year to present statistics and information bearing on this question. I believe there are a number of first-class electrically-driven plants in the country that keep information that would be of value to our members and it would be an interesting work for a committee to compile this data.

The motion was carried.

Prof. Hibbard: I remember that there were several papers which were not sent to the members by mail. Among them is the paper to be presented to-morrow by Mr. Pomeroy on the typical locomotive shop, especially, and some other papers; and I would inquire if these papers are printed, whether they might not be given us at this session, so that we may have an opportunity to read them with a little care previous to the time when we shall be called upon to discuss them.

The President: The Secretary says these papers are here, and they will be distributed at the close of this session.

We will now proceed to the topical discussions, which were deferred until after the discussion of Mr. Seley's paper. The first question reads as follows: "Is the Master Mechanics' Association Standard Front End Arrangement Best Adapted to the Modern Locomotive Having Wide Fire Box, Increased Length of Flues and Larger Grate Area?" This topic was to have been opened by Mr. James McNaughton, but in his absence Mr. John Player will open the discussion.

Mr. Player: In the absence of Mr. McNaughton he asked me to open the discussion for him. Our experience at the Brooks Works with engines having wide fire boxes is to the effect that practically similar smoke boxes are equally adapted to such boilers as those of similar size and capacity having ordinary fire boxes. The Master Mechanics' front end, as adopted by the Association, is, I believe, used on most roads, and modifications of it are used on a great many other roads. There are types of front ends which are used on still a third class of roads, differing from the standard of the Association, but the tendency of modern locomotive construction is to keep somewhat within the lines recommended by the Master Mechanics' Association as regards the dimensions and proportions of the exhaust nozzle and also stack. We have found in the construction of large engines, having large boilers, that to obtain an efficient front end that will make a good steaming engine, it is advisable to keep the distance from the center of the exhaust pipe to the flue sheet more than was used upon smaller boilers; that is, as you increase the size of the smoke box it is necessary to increase the distance from the center of the exhaust pipe back to the flue sheet in order to get an equivalent area back of the diaphragm to that used in smaller smoke boxes. I think that is one of the most important features to be considered in the arrangement of a front end. The diaphragm plate, of course, being placed back of the steam pipes in any arrangement of smoke box, it does not seem to make much difference what arrangement of netting is used, whether that recommended by the Master Mechanics' Association, which is a curved netting leading from the exhaust pipe to the top of the smoke stack, or whether it is

brought out straight and run at an angle, or whether it is brought along horizontally and brought back diagonally nearly to the base of the stack, or whether the arrangement known as the Snowden Bell arrangement is used. This is a series of two hoppers, the front one opening at the bottom with a piece of netting underneath. In our experience the Snowden Bell arrangement has given satisfactory results in many instances. In fact, in some cases it has given better results than the Master Mechanics' front end. The arrangement of the adjustable diaphragm plate, this long distance from the center of the exhaust pipe to the flue sheet, seems to give the best results just back of the exhaust pipe, although in many instances we have carried it ahead of the exhaust pipe with equally good results; but in those cases, where it has been carried ahead of the exhaust pipe, it has been on engines having a longer distance than usual from the center of the exhaust pipe to the flue sheet. In constructing large passenger engines having long flues, we have built some with flues 19 feet long and we have under contemplation some with even longer flues than that, which has been occasioned by the introduction of three pairs of large driving wheels and in some cases four-wheel trucks. In such cases, it is necessary to make the smoke box as long as possible to reduce the length of the flues. In such cases we have put the diaphragm plate ahead of the exhaust pipe instead of back of it, and we have obtained somewhat better results.

With regard to the forward portion of the front end, ahead of the exhaust pipe, it seems to be generally considered that a cinder valve is rather more a matter of ornament than use, and the majority of front ends are practically self-cleaning at the present time, if made short enough, and whether the cinder valve should be omitted or not is a matter for the Association to decide. I would like to have some of the other gentlemen continue the discussion.

Mr. P. H. Peck: I see that some of the roads have abandoned the cinder hopper. I noticed an engine in Chicago the other day with one, but the diaphragm of the engine stands considerably ahead of the nozzle so as to make the engine a self-cleaner.

Mr. David Brown: My opinion about the front end is this —

that what is good and serviceable for one kind of fuel may not be for another kind. The road with which I am connected up to within the last few years used nothing but anthracite fuel. Later we had a mixture of soft coal, the same as most other roads get, but with a pure anthracite coal we found that the arrangement for the front end proposed by the Master Mechanics' Association was not as good as the arrangement we were using at that time. Before coming to that conclusion we went over the whole matter very thoroughly. In my early railroad days I was on a road where they used soft coal, some of the best coal in the world, Welsh coal, and we used single nozzles. When I came to this country and saw the double nozzles in use I was astonished. I thought it was all wrong and when I got into a position to agitate the matter I got the master mechanic to try some single nozzles, but we did not get as good results from them for the reason that we had a long hill to climb; when we would adjust the nozzle to the right diameter for the hill, the engine would steam well while on the hill, but after reaching the top of the hill the fire was generally dirty and when we ran over the level with the light exhaust, we did not get steam. The same thing occurred on other parts of the road. Where we had the nozzle adjusted for hard work it was not satisfactory on lighter work. The consequence was that we decided that a variable exhaust was what was required and we went into that thoroughly and obtained better results in that way; but the saving did not overcome the expense and we finally abandoned the variable exhaust. We had three different kinds, and each one was too expensive to keep in order. We abandoned it and returned to the double nozzle and continued to use the double nozzle until 1899. We always had good steaming engines, with large straight stacks. In 1899 a superintendent of motive power was appointed and he decided our former practice was wrong; that what he had been used to was necessary, and he went into the choke stack and single nozzle, but things did not go as satisfactorily; the engines did not steam as well. We finally got soft coal and mixed it with the hard coal and we made out pretty well with the bituminous and anthracite coal mixed. Finally it came to the point where another superintendent of motive power took charge and we again used fine anthracite fuel, and to show that the straight stack and double nozzle is better for the anthracite coal,

what new power we are getting is equipped with the double nozzle, straight stacks and larger stacks. I know this statement will not be believed by many of the members present; but if they have anthracite-burning engines, and have about fourteen and a half inches choke stack on them, let them take off that choke and put on an eighteen inch diameter straight stack and double nozzle and they will find out for themselves that that is more satisfactory for fine anthracite fuel.

MR. QUEREAU: If I remember correctly, the Master Mechanics' Association committee reported resolutions and recommendations only on general principles governing exhaust pipe and stack; and incidentally mentioned the matter of petticoat pipes. The distance from the flue sheet to the exhaust pipe, the arrangement of the netting, and similar matters, were not investigated and reported on, except as incidentally showing the arrangement of the engine on which they made their experiments. I think we have no standard dimensions covering flue sheets or exhaust pipe or any standard arrangement of netting, as to whether there should or should not be a cinder hopper. I think the committee in its report referred only to the general principles governing the exhaust pipe, and the preference for the tapered as compared with the straight stack. There was no general practice recommended in regard to the petticoat pipe beyond the fact that a double petticoat pipe gave slightly better results than the single petticoat pipe. But no proportions or dimensions were given.

MR. G. W. WEST: I would ask Mr. Player what was the practice generally as to the location of the exhaust pipe, on the engines built in the ten years prior to 1900—was the distance uniform?

MR. PLAYER: I presume you mean with reference to the exhaust pipe and flue sheet. That was practically uniform. I think the distance on the majority of engines prior to the adoption of the Association's standard was somewhere in the neighborhood of 21 or 22 inches. There may have been isolated cases where it was different, but the general practice was within certain limits and about the dimensions given.

MR. WILLIAM MCINTOSH: I do not think it makes any particular difference whether the Master Mechanics' Association design of smoke stack and nozzle is applied to an engine burning

anthracite or bituminous coal. I do think the results, so far as these particular parts affect them, will be the same in either case. We are operating some locomotives with the Master Mechanics' design that are burning hard coal and doing it very successfully. One of our most recent engines is fitted with that design, almost exactly according to the recommendations. It is a hard coal burner, with rather small grate area, and is a splendid steamer, so that as far as the design is concerned, I think it is as suitable for one class of fuel as the other.

MR. P. H. PECK: All the engines we have are of the Master Mechanics' design. We had a great number of engines with various front ends, but as they went through the shop we changed them, until they are now all of the same kind. They are good steamers. We sometimes make a little change here and there to fit the peculiar draft of the engine. We use soft coal, a very cheap coal.

MR. SYMINGTON: As I understand it, the only difference between the modern engine, with large grates, and the old engines, is in the volume of gases which have to go through the flues and be taken care of in the front end. The front end is designed to give as large a vacuum as possible, and we believe the Master Mechanics' arrangement is as good an arrangement as any we have had for large vacuum in the front end with the old-style engines. I would ask Professor Goss, judging from his experiments at Purdue, whether he believes any change in the proportion of the Master Mechanics' front end design is necessary for taking care of larger quantities of gases.

PROF. W. F. M. GOSS: Since I am down for the discussion of a subject touching this general question, that is to come up during the session on Wednesday, I have been slow to participate to-day. In answer to the question I should say that no change would be necessary. The purpose of the front end is, as has been said, to bring the gases through the fire and tubes, and the fact that some change may be made in conditions at the other end of the tubes does not, it seems to me, affect the efficiency of the front end arrangement. Even though the grate is enlarged, or if the character of the fuel is changed, the character of the work to be done by the front end is not changed, and that arrangement which is

most efficient under one set of conditions at the grate is likely, it seems to me, to be equally efficient under another set of conditions at the grate.

In connection with this general discussion I would add that a question of interest to me concerns the diaphragm. I wonder if any one has tried to get along without the diaphragm. I have no doubt that an attempt to run an American locomotive with our present arrangement of stack and nozzle without a diaphragm would end in trouble; but we know that in foreign practice there is an arrangement of a high nozzle which works without a diaphragm and it is possible that there is a combination of an inside stack and nozzle which will permit American locomotives to operate without the usual diaphragm. I have done no work bearing upon this question, but inasmuch as the diaphragm absorbs a large amount of the energy produced by the action of the exhaust jet, there is abundant reason for eliminating it if this can be done.

MR. DAVID BROWN: As regards the diaphragm, we seldom use a diaphragm or draft pipe. We had a plate from the top of the flues down to a line with the bottom of the netting, which was between the exhaust pipe and the tip; the netting went between the joint and had room enough not to interfere with the joint. That is the only diaphragm we have. We had no draft pipe whatever and had good steamers. Occasionally some little thing might happen that we might want to make some little change and we would put a short diaphragm in front of the exhaust pipe. The reason we put it in front was that we considered it was easier on the steam pipes and the back of the exhaust pipe, as it did not get the cinder blasts punched into it opposite the flue, which naturally impinges against it and shows the mark of the draft, where the cinder strikes it; and by not having a plate behind the pipe, that difficulty was overcome to a very great extent.

MR. F. H. CLARK: We have a number of engines with the wide fire box and long tubes, and our experience confirms Prof. Goss' idea that no change is necessary in the general arrangement of the front end for engines with such fire boxes. We are using a smoke arch very similar to that recommended by the committee of this Association, a number of years ago, although we are not using

the petticoat pipe and in some other particulars are using a slightly different arrangement. We find, however, that an arrangement that works well with the engines having narrow fire boxes works equally well with the wide fire-box engines.

Mr. E. W. Pratt: On the Chicago & Northwestern we have several engines with the wide fire box and practically the same front end arrangement, that is, as regards the nozzles and stack, as the recommended practice of this Association, and they have given satisfactory service. However, touching upon the point that was made by Mr. Player as to the cleaning of the front ends of cinders, I think I may relate the result of an inspection made of the front ends of the one thousand and more locomotives of our road. The question had come up as to the elimination of the great expense due to the burning of the front ends; not only was it desired to overcome the expense of damage thereby, but also to overcome the bad appearance of the locomotives that did burn their front ends. The inspection extended over several trips on each locomotive and the facts were noted, particularly with regard to their cleaning their front ends of cinders. It was found, almost without exception, that these locomotives that did clean their front ends and practically dropped no cinders from the hopper valve whenever that was opened, very seldom had any trouble with burned front ends, while the opposite was almost invariably true of the engines that did not clean themselves. The effort was then made to adjust all front ends to clean themselves in service. In order to have this cleaning process take place, the netting back of the exhaust pipe on some of the locomotives that were "burning up" badly had to be entirely covered over and, in many cases, the diaphragms lowered. In some cases a double diaphragm was employed. That was found to clean the front ends of these engines that were giving trouble and it did away with their burning. Finally, some experiments were made to avoid the slight accumulation of cinders which always took place. This was accomplished by cutting a plate fillet in such form that it would lie in the bottom around the corner, if I may call it a corner, of the front end and gradually inclined upward to a point on the smoke arch front where the cinders naturally lie on most locomotives that are considered as cleaning their front ends well. By

putting in the plate we found these locomotives would practically clean out all the cinders from the front end. It would almost seem from these observations, that the hopper valve could be done away with and thus avoid one source of leakage and expense in front ends.

Mr. J. L. Lawrence: For the purpose of getting information, I would ask the last speaker what became of the sparks from the engines that seemed to clean their front ends so well, or did any sparks get into the front ends in the first place? If they got in, they evidently did not remain in. If they got out and went into the atmosphere, I should surmise there was fire along the right of way, unless a fine netting was used, and if so, I do not quite see where the sparks went to.

Mr. Pratt: It is not only my opinion but that of many others, that the definition of the part known as the "front end" has been changed in our minds, if not in the M. C. B. dictionary. It is no longer a receptacle for holding cinders until some convenient time for them to be dumped; it is more properly an arrangement for destroying their harmful effects and getting rid of the cinders.

Mr. Quereau: I have had some experience in the last few years with a self-cleaning front end design, and I would say, as a general proposition, that it is entirely feasible and practicable. It remedies the burning out of front ends, and with the design of which I am speaking there were less sparks thrown out from the front end than with any other. The design was such as to break the cinders up. The locomotives would come in trip after trip with hardly a handful of cinders in the front end and they did not start any fires, either. The experiences with these engines led me to believe as the result of experiments, that the front ends can be designed without any diaphragm, movable or fixed. I doubt if we have enough data to be able to design such a front end and know it will work, but in my mind there is no doubt that is the coming front end arrangement. On these locomotives to which I refer, the fixed baffle plate was perforated with a number of holes until by far the largest part of the area was holes instead of plate. I think the gentlemen will understand what I mean, although the last statement is rather a crude figure of speech. The results were satisfactory and there was no interference with the draft in

the fire box, and what was more important, the distribution of the draft in the flues was much improved. I am satisfied that in most locomotives, with the present arrangement of baffle plates, most of the work is done in the lower half of the flues, because the flues above do not receive an equal portion of the draft and hence of the heat. On the locomotives of which I am speaking, the flues failed very much more uniformly than they used to do. The usual results in service are that from 75 to 125 of the flues in the bottom of the flue sheet fail before the balance fail, and have to be renewed. With the locomotives in which the draft is more uniformly distributed, the failure was more uniform and the average life of the flues considerably longer. I agree entirely with Prof. Goss that when we once have the most efficient front end arrangement, it will be the most efficient regardless of fuel, size of locomotives, altitude or climate of the country in which it is used. In other words, the function of the front end is to produce a given draft through the flues with the least expenditure of power. When we have once obtained that, it should remain good for all conditions back of the front end. It is quite likely that it will be a matter of proportions rather than a matter of exact measurements; that is, if the proportions of a smaller boiler are followed out in the larger boiler, rather than the exact measurements, we will still have the most efficient front end.

PROF. H. WADE HIBBARD: Speaking to the question of the diaphragm plate, it would seem that there is an intimate connection between the diaphragm plate and brick arch, and the wider present fire box, the wider fire box being typical of the present-day construction of locomotive boilers. It would seem to me that if a diaphragm plate causes a greater draft at the front end to go through the lower boiler tubes, there would naturally be expected to be a need for the brick arch at the rear end of these tubes so as to counterbalance that and make more of the draft at back end start in at the upper tubes, so that the condition with the diaphragm plate and with the brick arch would be to distribute the current of gases through all the tubes, similar to the total absence of both diaphragm plate and brick arch. There are a number of reasons besides this, I believe, why a brick arch may be advisable, among them being the protection of the tubes from cold currents

from the open doors, the fly-wheel action of the heat energy stored and given out from the hot brick giving uniform fire box temperature, higher fire box temperature, because of deferred contact between burning gases and cold steel, the forced commingling of the gases and oxygen in the fire box, more complete ignition of all gases and fine carbon, etc.

One of the reasons, however, in this connection, for the brick arch, would be the prevention of too rapid coal combustion at the front end of the grate area, causing holes in the fire, and gases and excess air to go up directly from the grate to the lower tubes. The wide fire box gives you an opportunity provided you do not have a much greater number of square feet of grate area than with a narrow fire box, to have a shorter fire box. I believe we had reached the limit size of grate area with a narrow fire box, because we found that our firemen could not properly throw the fuel to the front end of the long grate area, and since they were not able to put the fuel in properly at the front end of that long grate, the fire brick arch was advisable to protect the tubes and to prevent the gases and cold air through the holes in the fire getting directly to the tubes.

With that same area of grate and the wide fire box, I think the average fireman is able to pitch his coal better, and so properly to cover the grate at the front end of that wide fire box. So that perhaps the development may be that with a wider, shorter fire box we could entirely omit the brick arch, and thus, in turn, entirely omit the diaphragm plate and still be enabled to get a proper passage of gases through both the upper and lower sections of tubes. Possibly that may be the development which may lead us into omitting the diaphragm in the front end, namely, the present wider grate areas.

Prof. W. F. M. Goss: The progress of this discussion prompts me to say a word with reference to the work accomplished by one of the Association's committees. Reference has been made to the Master Mechanics' standard front end. As Mr. Quereau has suggested there is no standard front end. The committee which accomplished the results suggesting such a statement was a committee appointed to investigate the subject of Exhaust Pipes and Steam Passages. What that committee did was to

investigate the form and proportions of exhaust pipes and nozzles. This work it did most perfectly and most thoroughly.

In connection with its report this committee presented a drawing of an entire front end, the proportions of which were suggested by their work; but that phase of the whole subject on which the committee sought to speak with authority concerns only the exhaust pipe and tip. So well was this done that we now think of the result of their labor as a standard. From the discussion this morning it is evident that whereas, before the report of this committee, all sorts of front ends were in use, there is now a general acceptance of the form suggested by that committee. Herein is so fine a tribute to the work of the Exhaust Nozzle Committee and to Mr. Robert Quayle, its energetic chairman, that we may well pause to give it emphasis.

MR. PLAYER: With regard to the matter of the diaphragm plate that Prof. Goss touched on, the object of moving the flue sheet farther back from the exhaust pipe in our practice was to distribute the draft better upon these larger engines. I fully agree with Prof. Goss that the elimination of the diaphragm plate can be effected, and I would move that a committee be appointed to further investigate the proper dimensions for a standard front end, and also to experiment upon the elimination of the cinder valve, and also to experiment in the direction of the elimination of the diaphragm.

MR. QUEREAU: The motion has not been seconded, as I understand. I do not want to take any credit away from Mr. Player, but I would offer a suggestion, and that is, that this work is being done now along that line in charge of Professor Goss, by one of our railroad papers. Our President suggested that our Association could do no better than to substantially help in forwarding that work; and it occurs to me that it will be better if we pass a motion that our executive committee be authorized to assist in the work now being conducted at Purdue University by the *American Engineer and Railway Journal.* I will make a motion to that effect.

The motion was carried.

THE PRESIDENT: As the time for adjournment is nearly at

hand, we shall not be able to take up any other business. The Secretary has an announcement to make.

THE SECRETARY: Vice-President West has named as a committee to consider the recommendations in the President's Address the following gentlemen: Mr. R. D. Smith, Mr. P. H. Peck, Mr. William McIntosh.

THE PRESIDENT: The second topical discussion for to-day will properly be the first one of the topical discussions at our next session. The session for to-morrow has been called for nine o'clock, adjourning at twelve, to enable us to take the train for Schenectady in the vicinity of one o'clock, for luncheon at the American Locomotive Works at Schenectady.

The convention then adjourned until Tuesday morning.

SECOND DAY'S PROCEEDINGS.

The Convention was called to order on Tuesday, June 24th, at 9 a. m.

Secretary Taylor read the application for associate membership in the Association of Fred A. Casey, vice-president of the Ashton Valve Company, of Boston.

THE PRESIDENT: I will state to the members who came here paying their own fare, that if they will leave their certificates in the office of *The Railway Age,* the one-third reduction in the fare for the return trip will be arranged.

The first business of the morning session will be the report on "The Up-to-date Roundhouse."

In the absence of the chairman of the committee, Mr. Van Alstine presented the following report:

REPORT OF COMMITTEE ON UP-TO-DATE ROUNDHOUSES.

To the President and Members of the
American Railway Master Mechanics' Association:

Your committee on above subject was continued from last year, and there was added to it one other member, namely, Mr. G. M. Basford, of the *American Engineer and Railroad Journal.*

In addition to up-to-date roundhouses, your committee was asked to

submit plans for up-to-date roundhouses recently constructed, and also to consider matters that pertain to them as accessories, such as cinder-pits, etc.

The subject as a whole is so great and there are so many points involved in it that your committee has deemed it wise to divide up the work. The division is as follows:

The chairman of the committee, Mr. R. Quayle, S. M. P. & M. Chicago & North-Western Railway: To describe and discuss plans of terminals recently constructed.

Mr. D. Van Alstine, S. M. P. Chicago Great-Western Railway: To present his ideas of an ideal plan covering and including all the desirable features.

Mr. G. M. Basford, editor *American Engineer and Railroad Journal:* To consider the details of terminals, including the details of recent construction.

Mr. V. B. Lang, M. M., C. N. O. & T. P. R'y, has been assigned the subject of operation of locomotive terminals, including sanding and coaling facilities, and the registering of engines in and out of terminals.

You will therefore readily see that while all the details of each paper presented in this report may not meet with the concurrence of each individual member of the committee, yet it has been considered wise to have the report presented in this manner, so that it will enable us to have a thorough discussion on the subject and also admit of a good deal of discussion on the part of each member of the committee, as there is much in this subject that no four men can agree to. Therefore, agreeable to the plans outlined, the following papers are presented:

PLANS OF TERMINALS RECENTLY CONSTRUCTED.

In the opinion of the writer, the above subject calls for the presentation of plans of roundhouses and terminals recently constructed, and to make such remarks about them as he may see fit.

The varieties of conditions are so numerous and yet so widely different from one another that it is with great difficulty that we are enabled to present a plan that would meet very many of the conditions that would be required. As a usual thing, the land on which the roundhouse is to be built would not be suitable for uniform conditions. I am not going to consider this, however. I will simply consider what is the best thing to do, provided you had plenty of land. I will therefore submit for your consideration, first: Fig. 1, which is a plan of roundhouse terminals at Clinton, Iowa, on the Chicago & North-Western Railway. This plan I submit for the reason that it is flexible, and one, two, three, four or more roundhouses may be set in line. This part of the road points east and west, and it is the opinion of the writer that the roundhouses ought to be set parallel with the tracks. I have designated several of the tracks by letters, so that when I make reference to them in the paper you may better understand what I am talking about.

At Clinton, Iowa, two divisions terminate. The Galena division, which runs from Chicago westward to Clinton, 138 miles, and the Iowa division, which runs eastward from Boone to Clinton, 202 miles. These are the lengths of both passenger and freight divisions.

At a busy terminal, where there are from 200 to 350 locomotives a day to be handled, it is very necessary that engines should have track facilities that will enable the locomotive to be moved from the roundhouse up into the freight yard to be coupled on to its train without any interruption by the opposing movement of locomotives. It is also necessary to have an additional track that will enable the locomotive to come from the freight yard up and into the engine-house without being detained by opposing engines. This not only holds true for freight locomotives, but also for passenger locomotives.

Therefore let us consider Fig. 1. I will first call your attention to the movement of passenger locomotives from the passenger depot, and I do this because on some roads they use a better quality of coal for their important passenger engines than they do on their freight engines; consequently they have the coal better taken care of, broken up and placed on the tender in better condition, and for this reason it is necessary to have one side of the coalhouse given over to passenger coal, and hence it is necessary to have a track on that side of the coalhouse over which the passenger coal is to be delivered to locomotives set aside for passenger locomotives, and on this plan the north track, marked "A," is known as the track for the movement of passenger locomotives. The depot being to the east of the roundhouse, the engines cut off from their trains and come up through the yard west-bound until they enter upon track "A," on which they pass up to the coal chute and take coal, and immediately at the west end of the coal chutes is the sand tower, from which they take sand. They then pass on down to the standpipe and take water, and then move to the switch which gives them a clear way over their cinder-pits and into their respective roundhouses, whether they be Galena or Iowa division engines.

Your attention is next called to the passenger locomotive leaving the house and going up to the depot to be ready to couple on to train after its arrival. If the passenger engine is in the west roundhouse, which belongs to the Iowa division, it will pass out of the roundhouse on the track to the east of the roundhouse, and will pass over what is termed the ash-pan pit, and if the ash-pan needs cleaning it will be cleaned out and the engine will pass onward down toward the depot, connecting with track "A," where they have access to a standpipe and can fill their tanks with water at that point, if necessary.

When passenger engines go out from the east roundhouse they go down to the east-bound track and take water at the same penstock, and on eastward to the depot.

Now, if you please, we will follow the freight engines from the point of giving up their freight trains to their arrival in engine-house. First, be it understood, that the freight yard in this plan is to the west of the round-

house and all east and west bound trains terminate in the same freight yard, and as it is located west of the roundhouse they all have to come eastward past the coal chute on track "B," and then cross over to coaling track "C," where they will take coal and pass westward to the switch, and go into either east or west engine-house in the same manner as described above for passenger engines.

The freight engines will come out of each of the east and west houses in the same manner as shown above for passenger locomotives, except that instead of going up to the passenger depot they will only go to the first switch and then head up on track "A," and if there are no passenger engines to detain them on the coalhouse track "A," they will pass on said track up into the freight yard. But should there be passenger engines taking coal at the coalhouse on track "A," they will take track "D," which we will call the run-around track.

This plan could be extended indefinitely so far as relates to number of roundhouses. Would also call attention to the fact that this plan calls for a depressed track, of which the writer is in favor, as his experience during some severe winter weather has caused him to discount very materially the use of pneumatic hoists for such purposes. Would recommend that we should always have pits long enough to at least clinker two engines at a time.

I next present to you Fig. 2, which is a plan of the McKee's Rocks yard, on the P. & L. E. R. R. This, for the lay of the land, makes a very desirable plan, and is a good deal the same as the Clinton plans, except that the positions of the roundhouses are reversed. In other words, the centers of these roundhouses are almost at right angles with the tracks.

Your writer is of the opinion that ash-pits should be as close to the roundhouse as possible, particularly in the northern climate, for the reason that when an engine has to run six, seven, eight hundred or a thousand feet, the cold air that passes up through the fire-box, even though the dampers may be closed before the engine gets into the house, is sufficient to cause the flues to leak, and this should be avoided wherever practicable. I believe the arrangement of the roundhouse and terminals as shown on Fig. 2 to be a very excellent arrangement. There is one thing, I find in this house, as well as in the Clinton house, namely, the tracks are in a straight line with each other across the turn-table, which is not only desirable, but enables the roundhouse foreman to handle his engines that are going on to the drop-pits, or engines that have to be taken into the shops for repairs. He can couple an engine on to a dead engine in one of these stalls and pull it out on to the turn-table without having to get a rope, or pole or post of any kind to push. Many of us know how inconvenient it is to get an engine part way out of the house and then get your men with pinch bars and pinch her the rest of the way to the table.

The next proposition is that of a single house, and I present to you Fig. 3, which shows the arrangement of tracks, roundhouses and other facilities for terminal at Collinwood, Ohio, on the Lake Shore & Michigan

Southern Railway. This plan is very excellent and speaks for itself without much explanation. There is one thing, however, that perhaps is not necessary for a house of its present dimensions, or even though the circle were completed, the two in-coming tracks, with a clinker-pit on each track. In discussing this matter with the men who are handling the cinders and cleaning the ash-pans of the locomotives, they tell me that it is very much more desirable for them, as well as more economical for the company, to have but one pit, and to have it of sufficient length to take care of all the engines going into the house, and the man in charge of the clinker-pit can take better care of his men at one pit than he can at two pits, and I concur with this opinion. And if 150 feet in length is not sufficient and two crews of clinker-pit men are not sufficient, make the pit long enough so that three or four engines and three or four crews can work on the same pit.

With this one exception, and it is no detriment to the plan; in fact, the second pit may be a good thing to have in case of emergency, no doubt, but from the experience of the writer he would not consider it necessary.

I notice on this plan that there are two out-going tracks, as well as two in-coming tracks from the roundhouse. Any one can take their choice of having it this way or having one in-coming track with a long clinker-pit and one out-going track. I think that this general plan is most excellent and would afford, no doubt, the minimum of delay and the maximum of expediency.

The next one is Fig. 4, which is another North-Western single roundhouse, or small plant. It might seem strange that the writer would put up two Chicago & North-Western engine-houses, but I think that he can be excused on the ground that after asking for many plans of this kind he did not find any that would seem to meet the requirements except those already offered, and therefore has been compelled to submit another one of the Chicago & North-Western.

You will notice that this is only an eighteen-stall engine-house, but ample room has been left for the extension to a complete circle. Fond du Lac being a terminal point, the engines come in from different directions, and on this plan we have shown (which is in actual practice) a track leading from the north yard up into the engine-house over which the engine passes and thence on to a clinker pit 150 feet in length. After the engine is clinkered, it passes down on the same track, taking sand and water as it goes into the house. The trains that come in to the south-end yard pass up toward the roundhouse and get the engines clinkered and take water and sand in the same manner.

When the business at this plant will be large enough to justify handling more engines, we will require two out-going tracks, one in either direction.

The details of the terminals are in the hands of one who will handle them much better than the writer, therefore he does not touch upon them.

ROBERT QUAYLE.

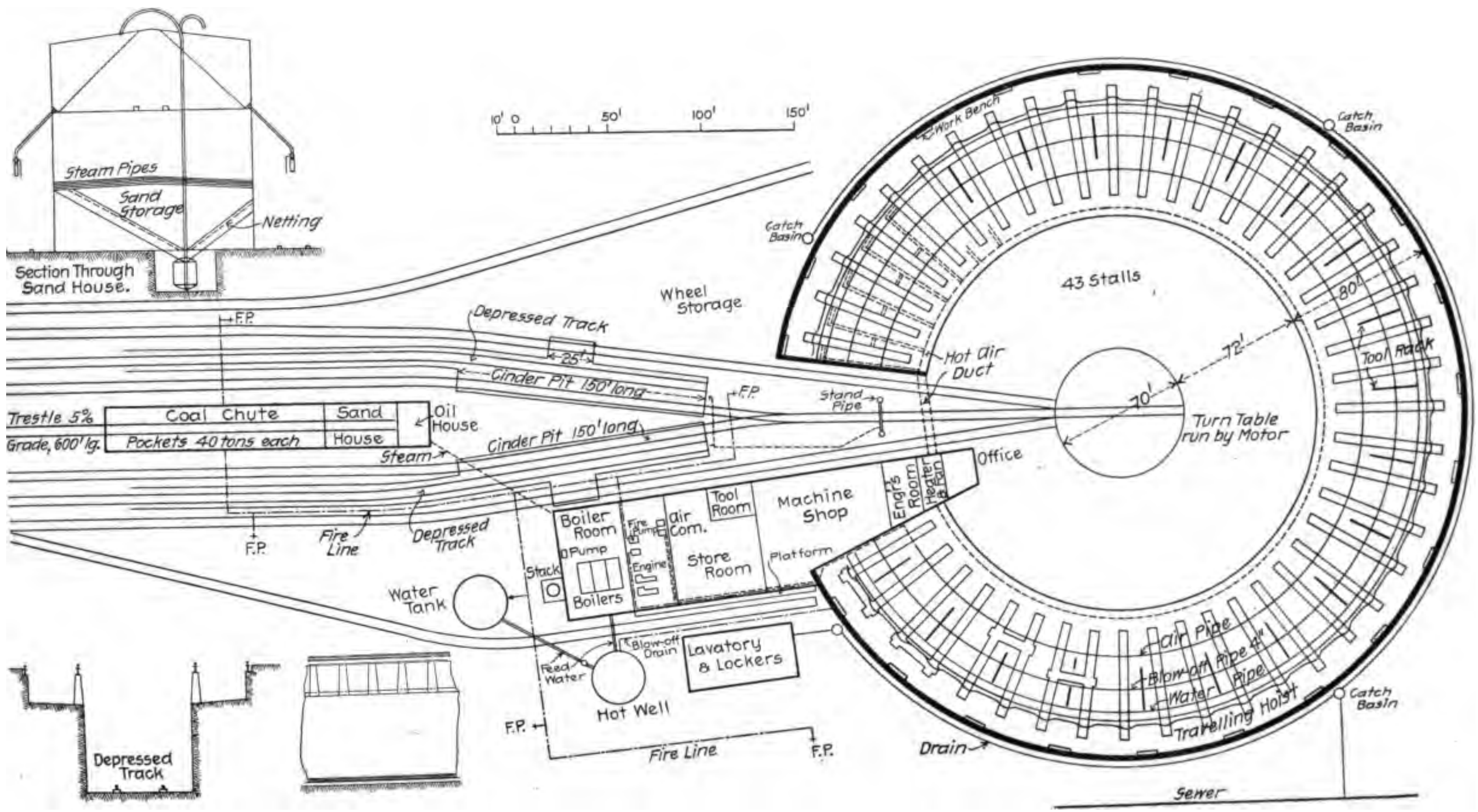

Section Through Sand House.
Steam Pipes
Sand Storage
Netting
10' 0 50' 100' 150'
Wheel Storage
Depressed Track
25'
Cinder Pit 150' long
Trestle 5%
Grade, 600' lg.
Coal Chute
Pockets 40 tons each
Sand House
Oil House
Steam
Cinder Pit 150' long
F.P.
Fire Line
Depressed Track
Stand Pipe
Hot Air Duct
Boiler Room
Pump
Boilers
Stack
Fire Pump
Engine
Air Com.
Tool Room
Store Room
Machine Shop
Platform
Engr's Room
Heater & Fan
Office
Water Tank
Feed Water
Blow-off Drain
Hot Well
Lavatory & Lockers
Fire Line
43 Stalls
Turn Table run by Motor
70'
72'
80'
Tool Rack
Work Bench
Catch Basin
Air Pipe
Blow-off Pipe 4"
Water Pipe
Travelling Hoist
Drain
Sewer
Depressed Track

FIG. 5.

THE IDEAL ROUNDHOUSE.

The ideal roundhouse, Fig. 5, is the one which handles engines with the least possible delay at the lowest possible cost. It provides in-bound tracks of sufficient length to store a large number of engines, on which are located coal chutes, sandhouse and cinder-pits.

The coal chutes consist of forty or fifty ton pockets on scales, into which hopper-bottom cars may be unloaded. The track above the pockets is reached by a four per cent or five per cent grade.

At one end of the coal chute are the sand pockets, which are filled from cars same as the coal pockets.

After the sand is dried it is stored in elevated pockets, from which it is drawn into sand boxes.

The cinder-pits are 150 feet long and depressed tracks about eight feet below bottom of cinder-pits to allow of cheap loading of cinders into cinder cars.

There should also be short cinder-pits in out-bound tracks for cleaning ash-pans of out-bound engines, and cleaning fires of switch engines.

Stand pipes should furnish water to engines on in-bound and out-bound tracks.

The turn-table is 70 feet long and operated by power.

The roundhouse is 80 feet long in the clear, with doors 12 feet wide and 16 feet high.

It is heated by hot air from heater and fan, which passes around the house through an underground duct on the inside circle, and is distributed to pits through underground pipes.

The air to be heated is not taken from inside the roundhouse. A hot well into which is drained all the exhaust steam from the plant as well as steam from engines blown off furnishes hot water for washing out and filling up, and for stationary boilers. The power-house boilers are arranged to burn front end sparks where the price of coal makes it profitable.

The engine-room is provided with engine, dynamos, washout pumps, fire pump and air compressors.

The machine shop is provided with lathes, bolt cutter, drill press, shaper, grindstone, planer, screw press, blacksmith forge and anvil.

The storeroom contains all necessary supplies, except oil, and a tool-room for small tools.

The engineer's room is located close to the roundhouse foreman's office and contains bulletin boards and desk.

The roundhouse foreman's office is centrally located.

The lavatory is provided with wash basins, shower baths, closets and lockers for engineers, firemen and roundhouse men.

The oilhouse should be conveniently located for taking oil cans to and from engines.

In the roundhouse are tool racks between pits for pinch bars, wrenches

and heavy tools, work benches on outer wall supported by brackets, drop pits for engine truck and driving wheels.

An overhead track for lifting smokestacks, smoke-box fronts, steam pipes, steam chests, pistons, cylinder heads, cross-heads, etc., electric lights, electric and air motors for cylinder boring, etc.

The overhead track has trolleys and chain hoists.

The drop-pits have hydraulic jacks on carriages for raising, lowering and moving wheels.

The rod man is provided with a work bench on wheels.

A wheel storage yard is conveniently located for getting wheels into and out of the roundhouse.

If fuel oil is used for fire kindling, a 6,000-gallon storage tank underground is located so that it can be filled from a tank car, and oil easily pumped from it for use in the roundhouse.

D. Van Alstine.

RECENT ROUNDHOUSES AND DETAILS OF CONSTRUCTION.

The Collinwood roundhouse of the Lake Shore & Michigan Southern Railway is a good example of modern conditions and equipment, put into service the past year. Its equipment includes a shop, a storehouse, oilhouse, locker-room, as well as coal, ash and sand handling facilities. Notwithstanding the close proximity of the largest repair shops on the road, the locomotive terminal was made complete in itself, in order to facilitate in every way prompt and efficient work on locomotives, to reduce to a minimum the delays and time out of service for running repairs, and other necessary work upon them. The general arrangement is shown in Fig. 3. Fig. 6 is a ground plan and section of the building, including the roof construction and location of the hot-air ducts and piping. The shop and storehouse is shown in Fig. 7. Other details appear in other sections of the report. This house has an inclined wooden roof, with ventilators in the roof and two intermediate posts for roof supports. This house is heated by a fan.

The Canadian Pacific fireproof roundhouse is illustrated in Figs. 8 and 9. The roof is inclined and is built of 18-inch I-beams, with two intermediate supports of 10-inch I-beams. The pits have 12-inch walls if of brick and 18-inch walls if of stone. On this road stone is preferred. This house costs about $1,650 per stall, exclusive of heating appliances and smoke-jacks, against about $1,300 per stall for the former standard, with brick walls and ordinary roofs. On this road steam pipes in the pits are used for heating.

A photograph of the new roundhouse for the New York Central at West Albany is given in Fig. 10. This engraving shows the roof construction, the floor, vise benches, heating coils, smoke-jacks and piping. Fig. 11 represents a number of recently constructed roundhouses on this road.

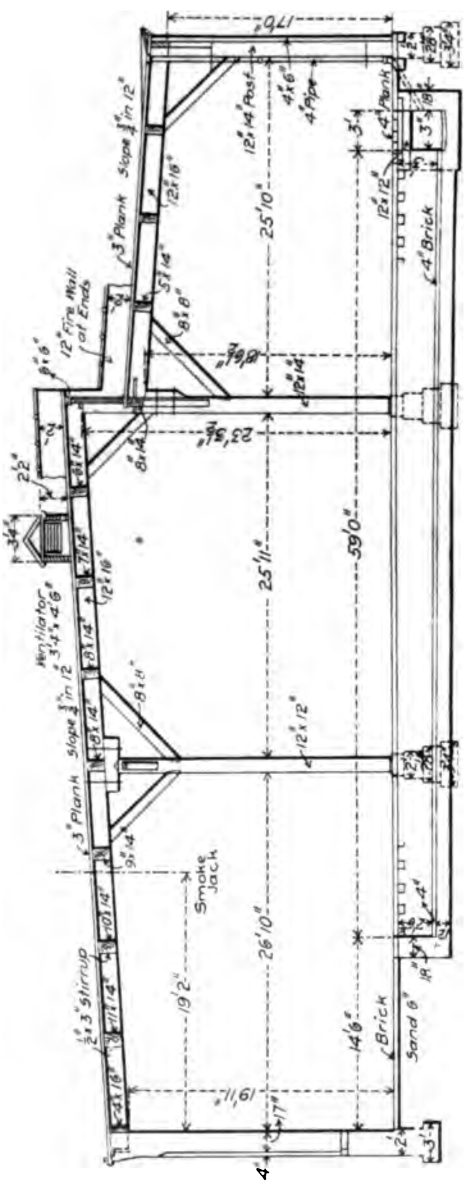

3" Plank
Slope 3/4" in 12"
12" Fire Wall at Ends
Ventilator
Smoke Jack
12"x14" Post
4" Pipe
4" Plank
4" Brick
Brick
Sand 6"
59'0"
25'11"
25'10"
26'10"
14'6"
19'2"
17'0"
12"x12"

FIG. 16.

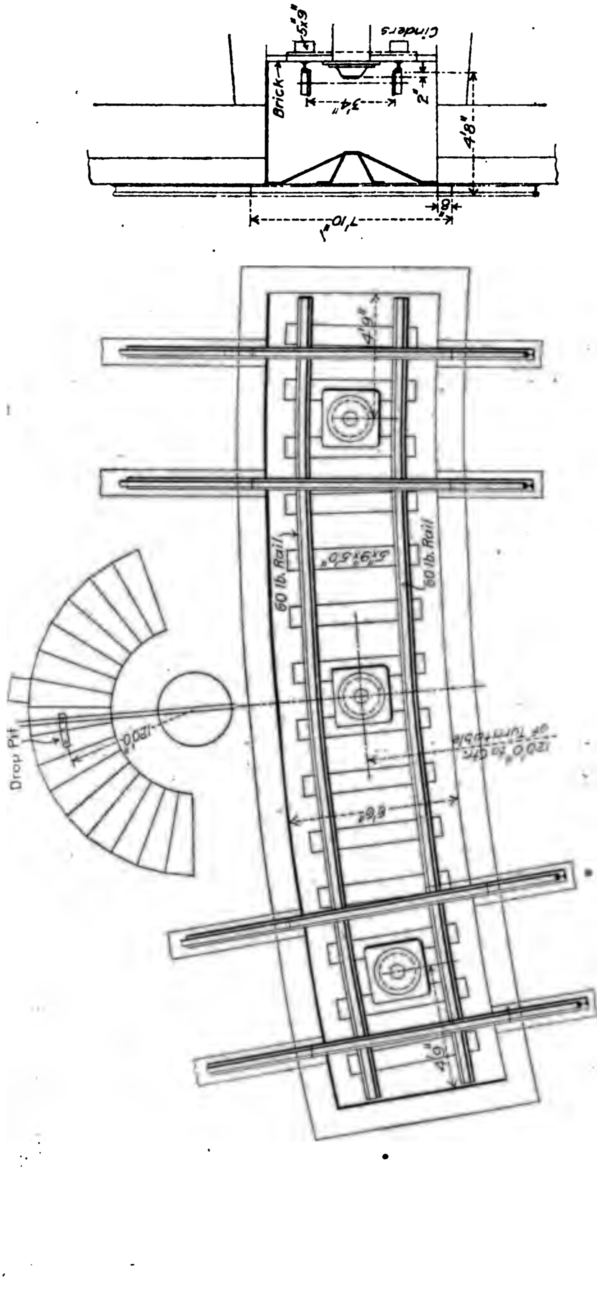


FIG. 38.

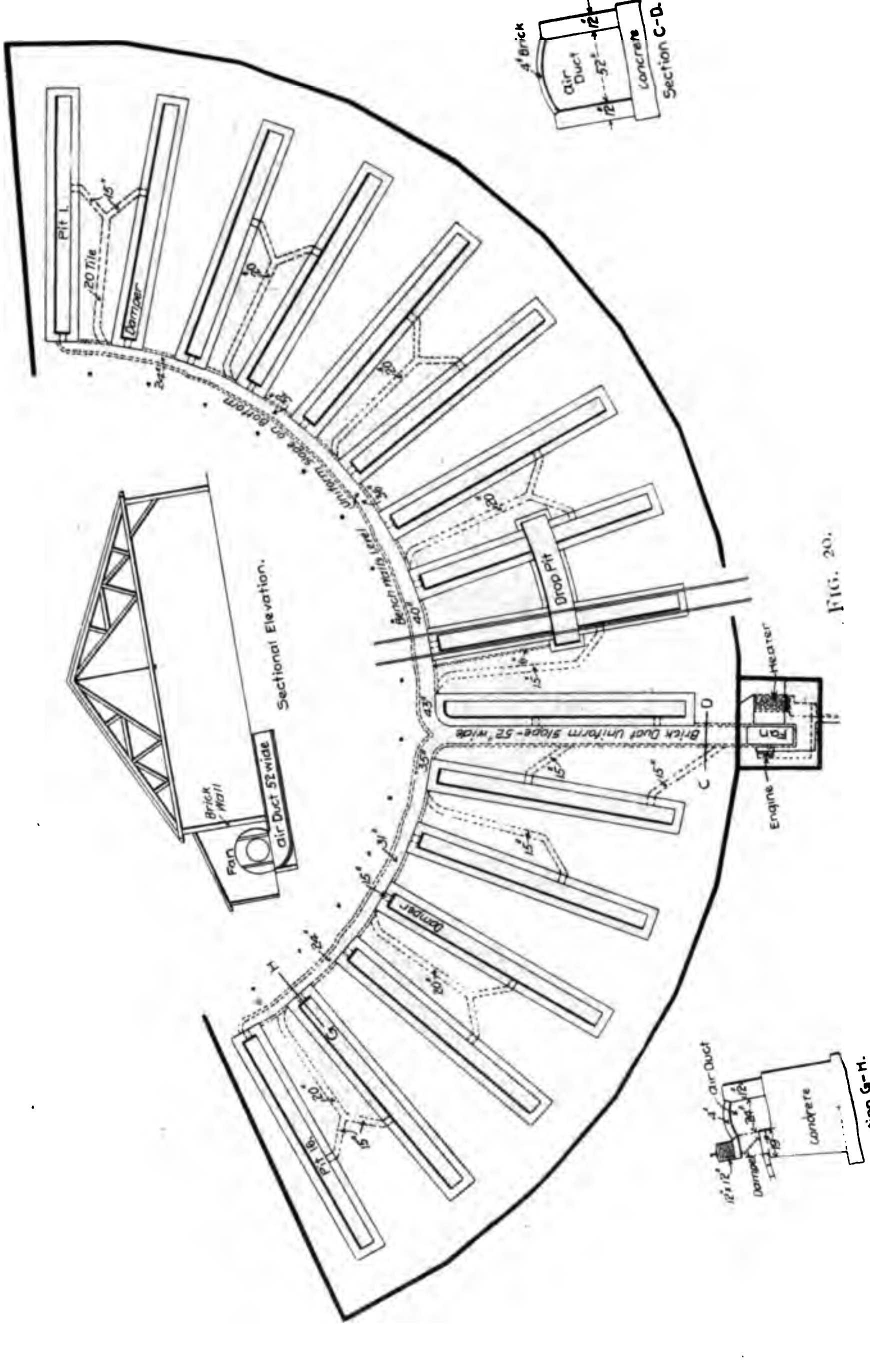

Sectional Elevation.
Brick Wall
Air Duct 52" wide
Fan
Section C-D.
Brick
Air Duct
Concrete
Section G-H.
Damper
Pit 1
Pit 16
20 Tile
Uniform Slope on Bottom
Bench mark Level
Drop Pit
Brick Duct Uniform Slope-52" wide
Heater
Engine

FIG. 20.

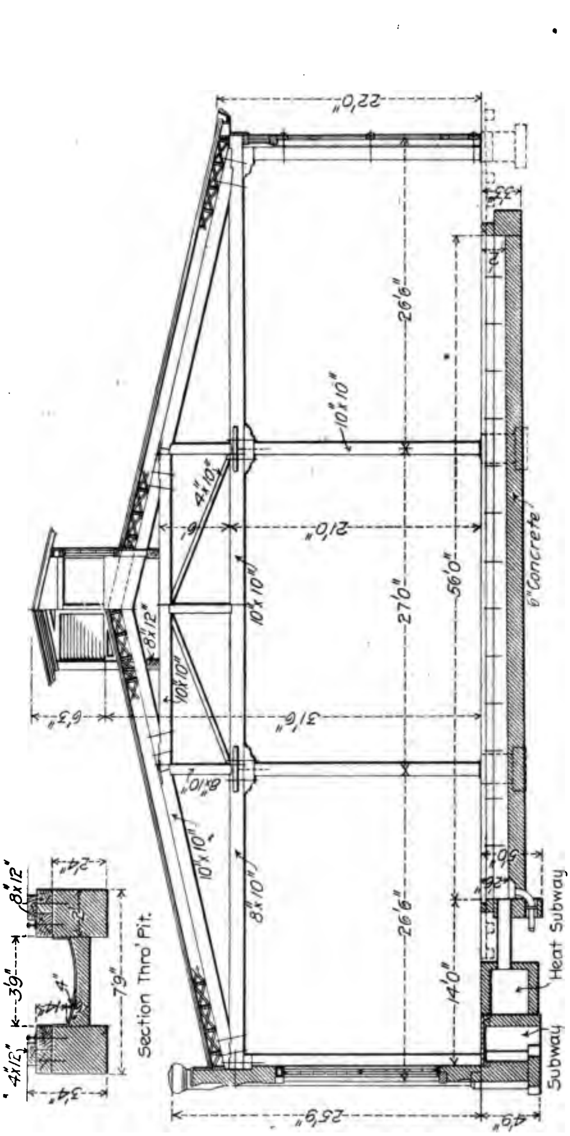

22'0"
26'6"
10"x10"
4"x10"
6'
21'0"
27'0"
56'0"
6" Concrete
10"x10"
8"x12"
10"x10"
6'3"
31'6"
8"x10"
10"x10"
8"x10"
26'6"
14'0"
Heat Subway
Subway
25'9"
4'9"
Section Thro' Pit.
4"x12"
3'9"
7'9"
8"x12"
2'4"
3'4"

FIG. 21.

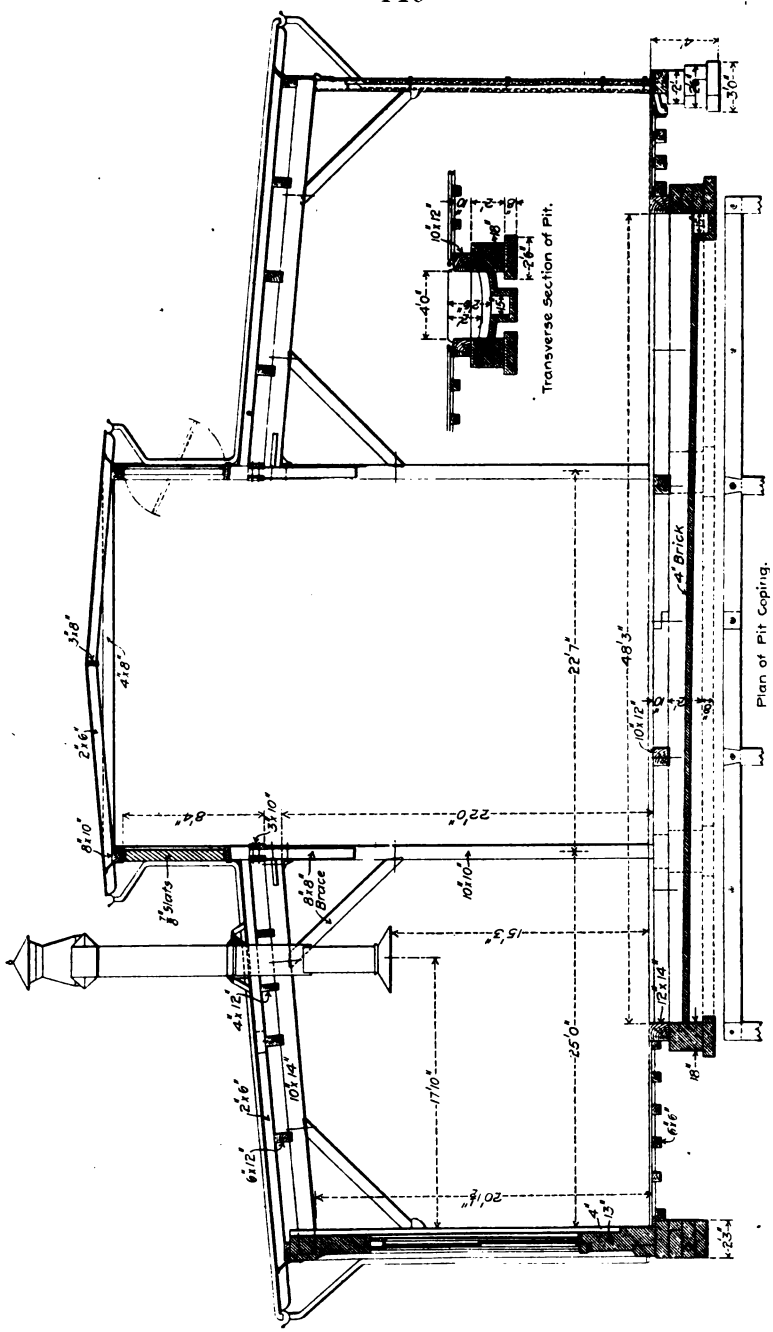

Transverse Section of Pit.
Plan of Pit Coping.
4" Brick
8"x8" Brace
7/8" Slats

FIG. 22.

truck wheels are usually provided, and on the C. M. & St. P. R'y a large pit, 8 feet 8 inches by 10 feet, sufficient to drop a complete engine truck, is put into each of the principal roundhouses. In many cases the pits merely provide for lowering and raising the wheels, but the best practice provides for lateral movement of the wheels when lowered, so that they may be removed from under an engine and raised to another track, for removal to the shop. Stationary jacks seem to be preferred. In Fig. 37 is illustrated the drop-pit, of concrete construction, of the New York Central, which is used in all new roundhouses. This pit serves two tracks, and reaches toward a third track a sufficient distance to permit of removing wheels at the end. The drawing shows the pit used with roundhouses of 418 feet diameter. In some cases drop-pits have been built with a curvature to a radius from the center of the turn-table. Those at Elizabethport of the Central Railroad of New Jersey and at Du Bois (see Fig. 38) on the B. R. & P., are so built. The drop-pit at Elizabethport takes in three tracks, which is advantageous. That construction is believed to be the best which provides for lateral displacement of driving and truck wheels with the least expense in masonry construction.

HEATING AND VENTILATION.

Nearly all large roundhouses of recent construction are equipped with fan systems, these being considered as furnishing the ideal method of heating. For small houses, steam pipes in the pits seem to be the most economical. In the plans accompanying this report are a number of different arrangements of conduits from the fans, most of them underground. The conduits may then be of brick and concrete and are permanent. When underground they are also entirely out of the way and do not obstruct the light. Various methods are employed to distribute the hot air to the pits, the chief point of interest being the methods of delivering the air under the engines and tenders for the purpose of quickly melting snow and ice. These require no comment, but it is evident that the plans are not of equal merit in this respect. The roundhouse pits of the Jersey Central at Elizabethport (Figs. 18 and 19) are fitted with elbows to direct the air to the machinery. These, when pushed into the bushings in the walls, automatically open the delivery dampers.

For good ventilation the volume of air required from the fan is much greater than is required to pass through the fan for heating alone. A good rule is to require the air to be renewed every eight or ten minutes. Practice in heating and ventilating is not by any means uniform, and an attempt has been made to secure information which shall be a guide to good practice.

The variable factors are: Volume of house per stall, outside temperature range, character of exposure, use of live or exhaust steam, location of fanhouse, space available for fan and amount of heated air to be returned to the fan. In a roundhouse the air should not be returned to

the fan. The form of roof affects the heating. An average of about thirty-three thousand cubic feet of space per stall seems to represent usual construction. About two thousand cubic feet of air delivered per minute per stall gives good results. The committee found one case in which eight hundred cubic feet per minute seemed to be ample. A range of from 125 to 150 degrees Fahr. seems to be satisfactory for the delivery temperature. To estimate approximately the amount of steam in pounds per minute required for the heater, multiply the total volume of air supplied per minute by the number of degrees to which it is heated, divided by the constant 55.

In order to secure definite figures, one of the leading firms of engineers, making a specialty of heating and ventilation, was asked to submit suggestions based upon the roundhouse shown in Fig. 5 of this report, the conditions being those of the climate of Chicago, the minimum outside temperature being 20 degrees below zero, the inside temperature to be 70 degrees, and the range of temperature of the hot air to be from 125 to 150 degrees. This information is as follows:

Number of stalls	42
Approximate cubical contents per stall	34,700 cubic feet
Air supply per stall per minute	2,000 cubic feet
Total air supply	84,000 cubic feet
Temperature air supply	140° Fahr.
Size of fan	11 feet
Speed of fan	150 r. p. m.
Size of engine	11 by 14
Lineal feet in heater	8,500 to 9,500

"These figures are subject to some change, depending, first, upon the character of the exposure, the probable minimum outside temperature, variable steam pressure, and the amount of hot air returned to the fan. You can readily see that unless we were given a specific case and knew all of the conditions pertaining thereto, it is quite impossible to figure closely.

"We enclose herewith a sketch (Fig. 39) in which is shown in dotted line a suggested system of underground conduit for this roundhouse. We have shown also the approximate size of this conduit. If the fact that it is arranged to run under the radial tracks is a disadvantage, it could, of course, be placed near the outer wall. The proportions of this sketch are probably wrong, because the blue-print enclosed is not scaled. The dimensions thereon are evidently not intended to be perfectly accurate.

"Assuming the cubical contents per stall about thirty-four thousand cubic feet, and assuming the temperature of delivery 125 degrees, a careful computation, taking into account only the heat loss from walls, roof and windows, and making no allowance for the opening of doors and other accidental ventilation, we find that it will be necessary to supply 1,200 cubic feet of air per minute per stall to maintain an inside temperature of 70 degrees, with an outside temperature minus 20 degrees. In order, there-

fore, to safely provide for accidental ventilation, the air supply should not be less than two thousand cubic feet. This will serve to show that an air supply of eight hundred cubic feet would hardly be large enough unless there were unusually favorable conditions to be met."

To secure the best conditions of ventilation and heating, it seems wise

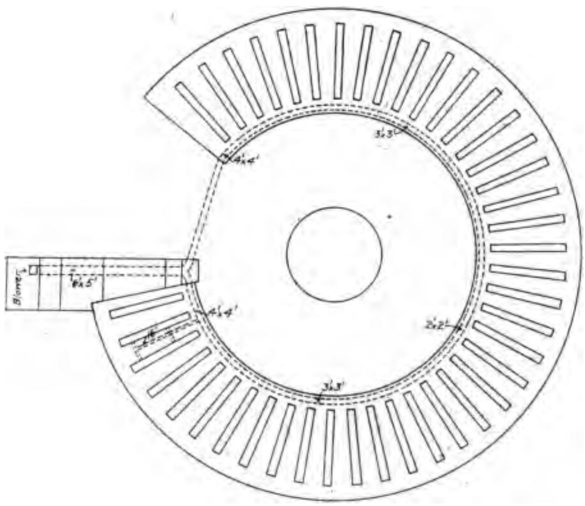


FIG. 39.

to consult the leading firms dealing in this apparatus and provide a liberal appropriation for the equipment, and to secure a fan capacity far greater than sufficient to maintain a comfortable temperature at all times, then to drive this fan hard enough to secure good ventilation through the smoke-jacks and roof ventilators.

SMOKE-JACKS.

Nothing new in smoke-jacks has come before the committee. Wooden jacks, fireproofed with paint and sand, appear to be growing in popularity. They do not corrode. Telescopic jacks continue in favor where they are used, also those of tile and those having swinging lower sections to accommodate slight displacements of the engines.

BLOW-OFF AND WASHOUT PIPING.

There seems to be a marked tendency toward putting all water and steam piping about roundhouses in conduits under ground. When exposed to gases the piping is apt to become leaky and this soon leads to great dis-

comfort from the dripping of water and blowing of steam. Air and steam blow-off pipes are run overhead without serious inconvenience.

Blowing down. the steam and water from boilers usually requires a long time, and better facilities should be provided. If steam is blown

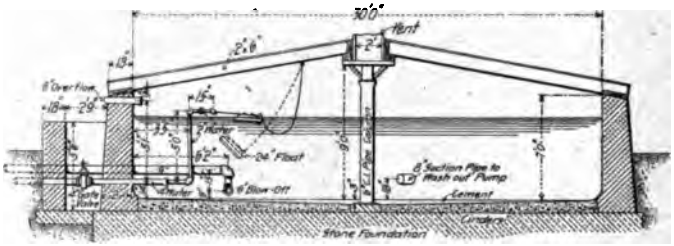


FIG. 34.

down from the steam domes a large pipe and large connection should be provided or the process will be too slow. Ideal practice would blow this steam off into a cistern to heat water for washing out. This is done at Collinwood, as illustrated in Fig. 34.

The water from the blow-off cocks is often run off into the roundhouse pits and allowed to pass into the drain. At West Milwaukee, on the C. M. & St. P., the ash-pits and roundhouse-pits are piped for flexible joint connections to the blow-off cocks and the water disposed of to the drains, without filling the air with steam. This is an excellent plan, shown in Figs. 35 and 36, but there seems to be no objection to piping this water to the cistern for use again in washing out boilers.

The P. & L. E. roundhouse at McKee's Rocks has ten pits set apart for boiler washing. These are piped to the sewer to avoid the escape of steam. There seems to be need of improvement in methods of washing out boilers. It should not require four hours to do this work, and yet this is quick time under average conditions.

LIGHTING.

For lighting the interior of a large roundhouse one large arc lamp at each pit, about fifteen feet from the floor and about twenty-five feet back from the front end of the engine seems to answer very well. Incandescent lamps, three between each two pits, with additional portable lamps for attachment to plugs at the posts, seem to serve equally well.

FLOORS.

A good floor, adopted by the New York Central for roundhouses, is prepared as follows: Upon a leveled sub-grade an 8-inch bed of cinders is placed and thoroughly rammed. Upon this is placed a 5-inch layer of concrete, consisting of one part of portland cement, four parts sand, and seven and one-half parts of broken stone. Upon this is a top dressing, one

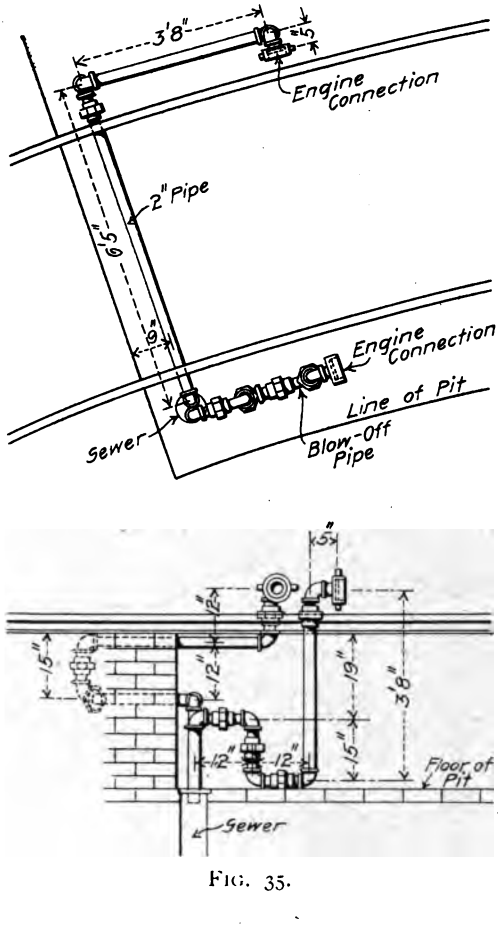

3'8"
5"
Engine Connection
2" Pipe
6'5"
9"
Engine Connection
Line of Pit
Sewer
Blow-Off Pipe
5"
12"
15"
12"
19"
3'8"
15"
12"
12"
Floor of Pit
Sewer

FIG. 35.

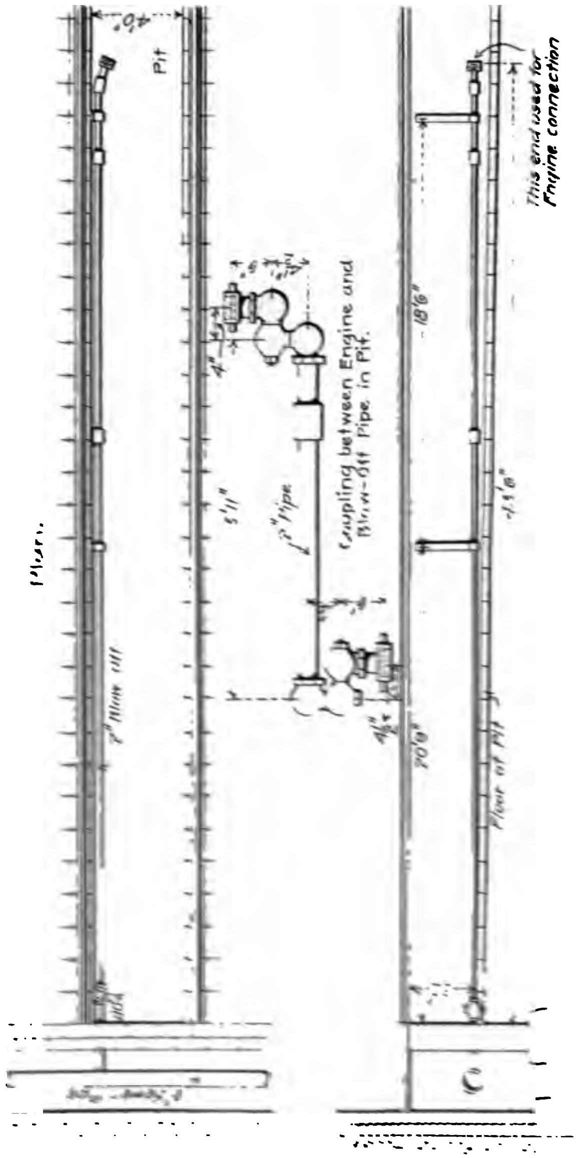

Pit
Coupling between Engine and Blow-Off Pipe in Pit.
This end used for Engine connection
18'6"
20'0"

Fig. 23.

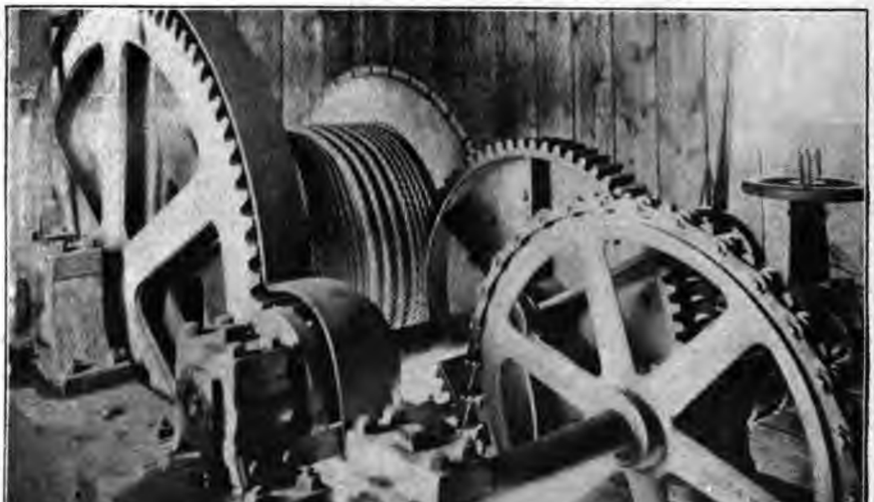


Fig. 24.

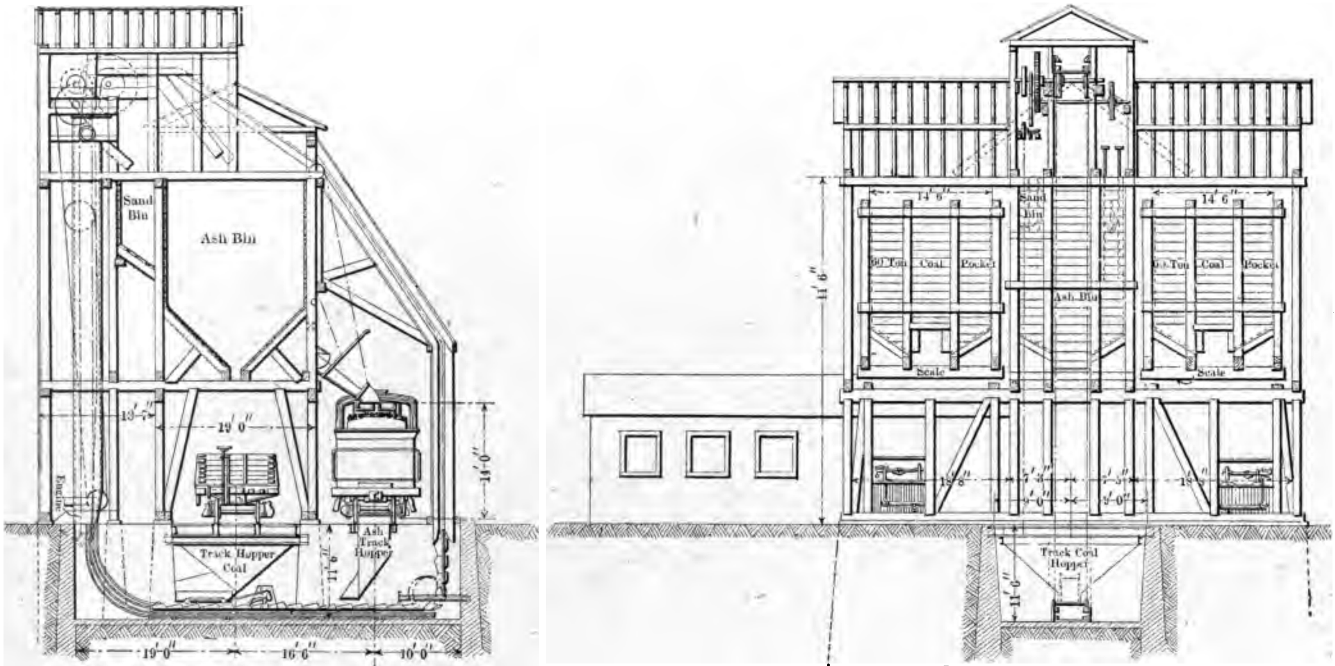
inch thick, composed of one part portland cement and one part of sand. This is deposited simultaneously with the concrete to insure a perfect bond. The top is surfaced true with long, straight edges, and is floated to be smooth. Drainage is secured by raising the floor to a height of two inches above the rails, midway between the pits. This floor has been used for seven years by the New York Central with satisfactory results. It has no lodging places for water, dirt or grease, and is easily kept clean. It is also easily repaired. A good floor is also made by setting vitrified brick on edge in tar. Care should always be taken to secure perfect drainage and maintain a dry floor.

COAL, SAND AND ASH-HANDLING FACILITIES.

Coaling plants for locomotives have been described in the proceedings of this Association, but it seems advisable to include recent improvements in connection with the subject of the roundhouse.

A recent installation on the Santa Fe at Lorenzo, Illinois, is illustrated in Figs. 23 and 24. Cars are hauled up the incline by a wire rope by means of a hoisting drum, which is driven by a 30-horse-power Otto gasoline engine. One man operates the machinery, which has a capacity of one hundred and fifty thousand pounds gross weight on a twenty per cent incline at twenty feet per minute. From the car the coal is delivered to the tender by gravity. At the top of the incline the grade is one per cent, sufficient to start the cars at any time. Cables six hundred feet long are used in these plants. This is enough to permit of switching eight or ten cars with the hoisting apparatus, a switch being provided at the bottom of the incline for this purpose. The band-brake on the friction drum used in lowering the cars and the friction clutch is to hold a car at any desired point on the incline. The hand-wheel controls the band-brake, and it is easily operated. This brake seems to be a vital feature in the success of this hoisting arrangement.

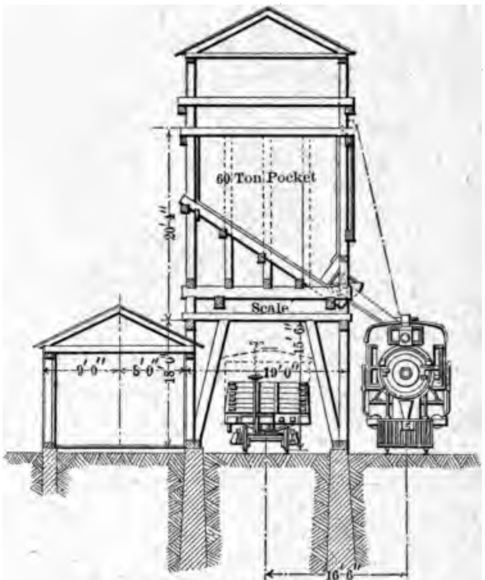
Another plan, which has been extensively introduced on the Chicago & Alton, is illustrated by Figs. 25, 26 and 27. While various arrangements are employed, these engravings illustrate the principles which seem to be most important. This construction combines coal, ash and sand handling facilities in one plant. Coal storage for three hundred tons or more is also included. The chief interest in this plan centers in the large pockets (sixty or one hundred tons) which are capable of taking the entire load of the largest coal car, and in the fact that these pockets are suspended on scales, from which the amount of coal delivered may be actually weighed and autographic records of the delivery made for the attendant and the engineer. The plant covers two tracks, one for the receipt of coal from cars, and the other for locomotives to stand while they take coal and sand, and have their ash-pans cleaned. Coal from the cars is received in an underground hopper, and may be taken by the conveyor to the delivery pockets or to the storage. It may be taken by the same conveyor from the storage into the delivery pockets without shoveling. A hopper under the ash-pan



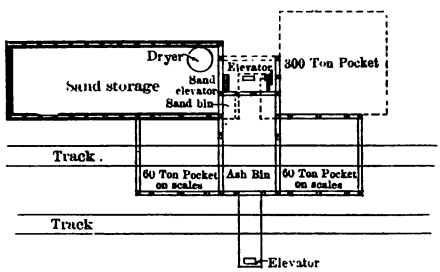
Section Through Pockets

Longitudinal Elevation of Pockets
Pit and top of Building in section

FIG. 25.



Section Through Pockets on Scales. *A.E.*



Plan of Buildings. *A.E.*

FIG. 26.

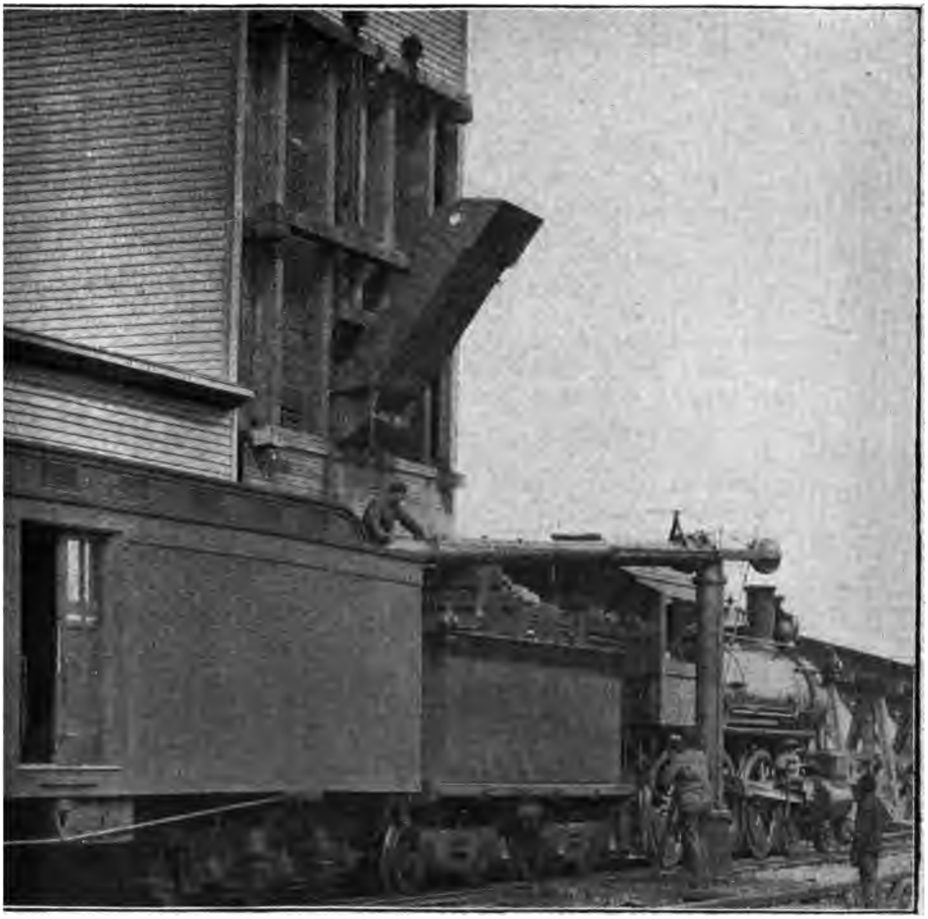


FIG. 27.

of the engine receives the ashes and by the same conveyor they are deposited in an elevated bin, to be chuted from time to time into a car for removal. Sand is stored in an annex, and after drying it is raised by an elevator into an elevated bin and chuted to the sand boxes of the locomotives. This design was developed and is manufactured by the Link Belt Machinery Company, of Chicago. Among the details of this construction is an undercutting valve in the delivery chute, shown in Fig. 27, which can not become clogged by lumps of coal. It is intended that the entire plant shall be handled by one man. Similar facilities have been supplied to other roads. It is claimed that this apparatus handles coal at a cost of 2 cents per ton. Attempts to weigh coal pockets have been made before, but this is believed to be the first successful application of scales to large pockets, with an arrangement which does not require shoveling. This is an exceedingly comprehensive combination. It is, however, dependent upon the machinery, a failure of which would "tie up" the ash as well as the coal handling facilities. For power 15-horse-power Otto gasoline engines are used in these plants on the Chicago & Alton. In connection with these plants the water cranes have been located so that water may be taken at the coal pockets, and thus all of the outside work is done at one time and at one place. For larger roundhouses the same facilities may be duplicated to provide for several engines at a time.

SANDING PLANTS.

Where the demand for sand is large, as on roads with a concentration of a large number of engines in a small territory, it seems advisable to install central sand drying outfits and distribute the dry sand in box cars.

At Middletown, New York, the New York, Ontario & Western has a sandhouse of brick, 25 by 46 feet in size, which is illustrated in Fig. 28. Sand is received in gondola cars and shoveled through one of the windows. From the dryer it falls into a hopper and passes into a sand reservoir, from which it is elevated by compressed air into the dry storage for delivery to the engine on the tracks outside of the building. Other tracks may be reached from the storage bin if desired.

At Collinwood, on the Lake Shore (Fig. 3), sand is received over the coal-chute trestle, at the end of which it is dropped from the car into a storage bin, Figs. 29 and 30. It is shoveled into a steam dryer and falls into either of two sunken reservoirs. From these it is elevated through straight vertical pipes into the dry storage above, and is ready for the engines. On applying air pressure to the sunken reservoirs of Fig. 30 the air first passes through a vertical cylinder. It raises the piston of the cylinder and closes the entrance from the dryer by means of a large rubber ball, "C." When this ball-valve is closed the piston is high enough to uncover the opening to pipe "B," which admits the air to the reservoir and elevates the sand.

Fig. 31 illustrates a rotary sand dryer used on the Chicago, Milwaukee & St. Paul at West Milwaukee. The sand used there is very wet, and with

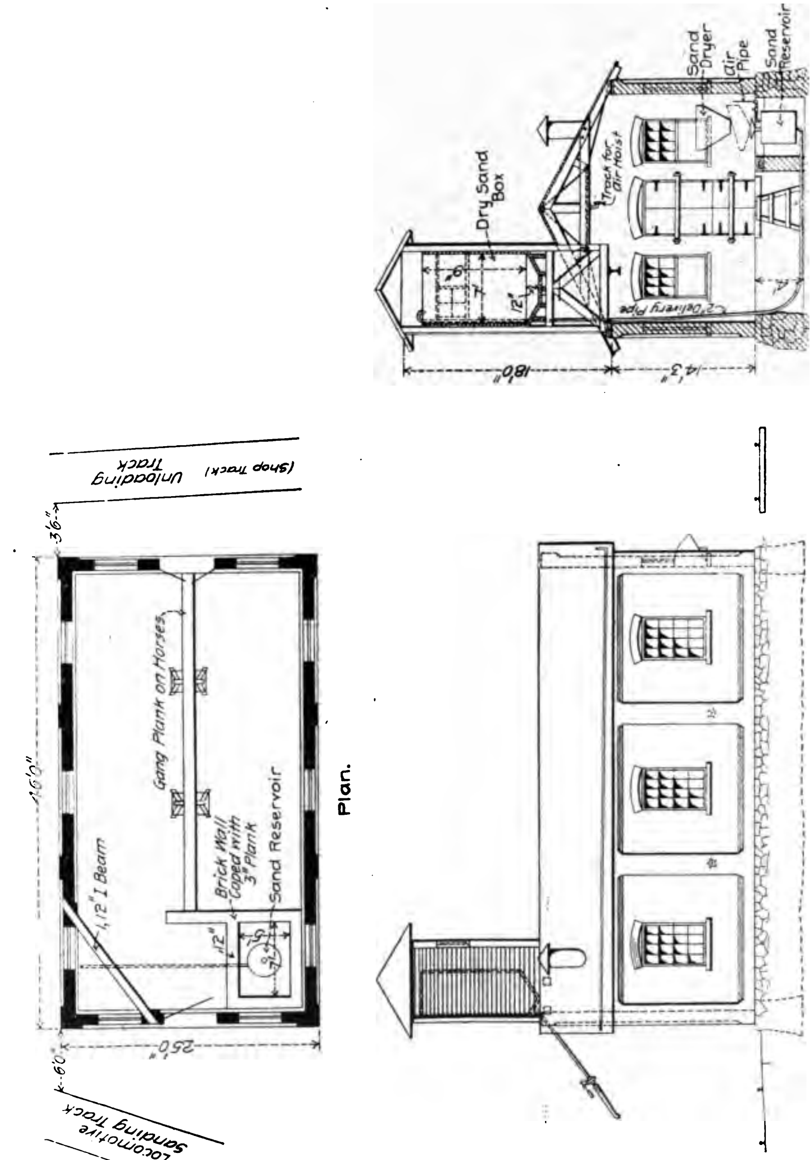

Dry Sand Box
Track for Air Hoist
Sand Dryer
Air Pipe
Sand Reservoir
2" Delivery Pipe
18'0"
14'3"
12"
Cross Section.
Unloading Track
(Shop Track)
3'6"
16'0"
25'0"
6'0"
Gang Plank on Horses
12" I Beam
Brick Wall Caped with 3" Plank
Sand Reservoir
Locomotive Sanding Track
Plan.
Elevation.

FIG. 28.

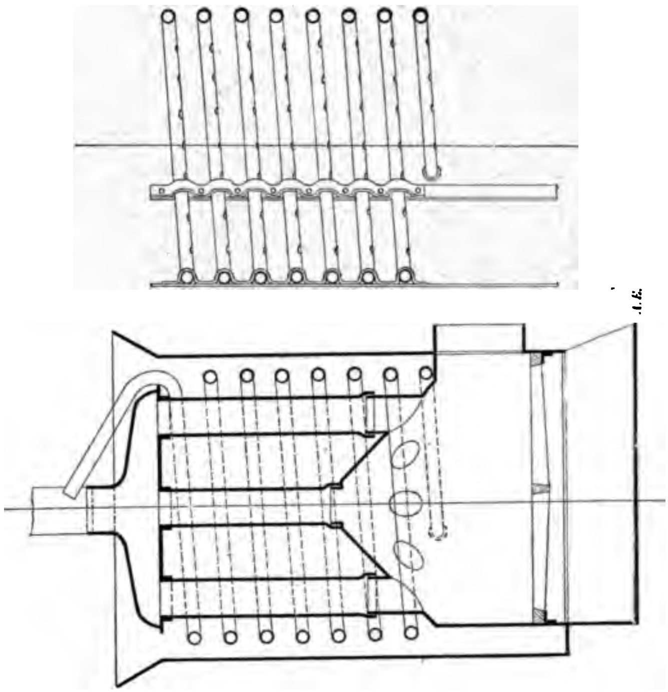


FIG. 32.

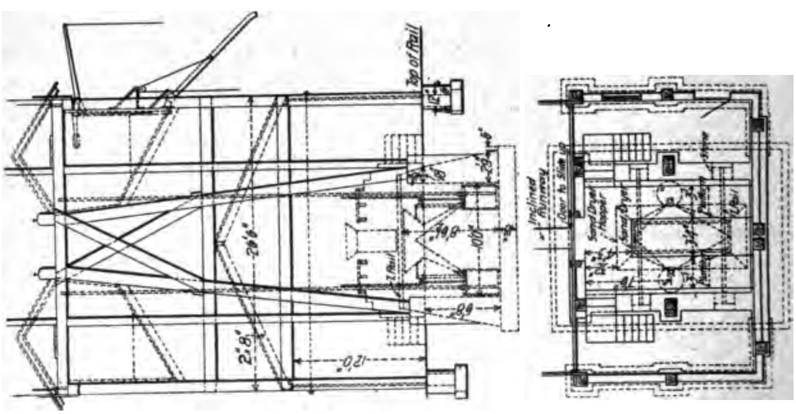


FIG. 29.

it the machine has a capacity of ten cubic yards in twelve hours. This dryer is of boiler plate; it is inclined and screens the sand at the lower end. It is rotated by power, and when automatic conveyors are installed to deliver the green sand its capacity will be increased somewhat, and the labor cost of operating will be reduced one-half. The engraving, Fig. 31, shows a single grate. The dryer in use has two grates.

An improvement introduced on the Chicago & Alton, whereby the drying of sand is facilitated by the use of a perforated pipe to take away the moisture, is shown in Fig. 32.

ASH-PITS AND HOISTS.

Ash hoists are used in many forms for raising ashes from the ash-pits. Compressed air is generally used to raise buckets from the pits, one form of construction being shown in Fig. 33. The ash-pit is supplied with a number of clam-shell buckets, resting in cradles, with wheels to run on the pit rails beneath the engines. The hoist dumps these buckets into a car on the adjacent tracks.

One large road is preparing to install an electric traveling crane over its ash-pits, believing that this will be the most satisfactory device which can be used for this purpose.

The depressed-track ash-pit has not been altogether superseded by power devices, and is believed by many to be cheaper and more satisfactory than more elaborate equipment. Local conditions, however, do not always permit its use. When these tracks are used the pits should be of ample length, and the depressed track should be low enough to bring the top of the cinder car to the level of the ash-pit rail, and the side of the car should be very close to the rail. It requires rather careful study of conditions to determine the point where the advantage of power ash-hoisting devices begins. This depends upon the number of engines and the available time of men who must be on hand for other purposes. Fig 13 illustrates the standard double-track ash-pit of the New York Central.

WATER CRANES.

The most notable improvements in water service seems to be those on the Chicago & Alton, one of the new cranes being shown in Fig. 27. This crane is unusually flexible, and has a 15-foot spout. When locomotives stop on the single track in either direction to take coal the tender must be opposite the center of the coal spout. This would bring the man hole of most tenders about twelve feet to the right or left of the wate spout. With the long water spout the manhole may be reached in eithe case without moving the engine. This long spout is used only for singl track stations, requiring the engine to make an exact stop at the same pla in either direction for coal. This water crane delivers water at the rate from four thousand to six thousand gallons in one minute, depending up the length, directnesss and diameter of the pipe. While this seems, p

haps, unnecessarily large capacity for roundhouse service, it seems desirable to point out the importance of every time-saving facility at roundhouses as a money-saving investment. Standard water-crane apparatus is now being furnished which will supply 6,500 gallons per minute. The Chicago & Alton and Chicago & North-Western roads are leading in the installation of this equipment. Nearly all of the standpipes recently put in on these roads are twelve inches in diameter.

ROUNDHOUSE SHOPS.

Irrespective of shop facilities for repairing locomotives, roundhouse equipment must now be kept up to a high degree of efficiency in order to reduce to the minimum the loss of time in doing the necessary work at terminals. In the present state of business the roundhouse must be near a shop, or it must have shop facilities in its own equipment.

The new Lake Shore roundhouse has a convenient shop, Fig. 7, with the following tool equipment: A 26-inch triple-geared shaper; 36 inch by 36 inch by 12 foot planer; 18-inch engine lathe, with 5-foot bed; 30-inch drill press; 24-inch engine lathe; a sensitive drill; a single Acme bolt-cutter; double-arbor emery-grinder; blacksmith's forge; pipe-bending blocks and two screw presses. The Chicago & North-Western roundhouses have small special shops adjoining, and so also have the new roundhouses on the New York Central. Fig. 12 illustrates one of these, at White Plains, New York. This subject was prominently mentioned in the report of last year.

POWER-DRIVEN TURN-TABLES.

Locomotives have become so heavy, and the demand for quick roundhouse service so urgent, as to necessitate power-driving for turn-tables, where many locomotives are handled. The choice of power depends upon circumstances. Electric motors are most satisfactory when power is available both night and day, and electric equipment is the simplest and most cheaply maintained. When an independent equipment is necessary, the gasoline engine offers peculiar advantages. It is the cheapest to install and is reported to be satisfactory. Compressed air and steam are also satisfactory and convenient. In cost of operation electric motors and gasoline engines are about the same, the expense for turning 250 engines every twenty-four hours being about $4, including repairs, gasoline or electric current. The cost of installation of a motor equipment is about $1,400. That of a gasoline engine is about $1,000, and that of a steam engine $1,200.

The courtesy and assistance of the *American Engineer*, the *Railway Age* and *Railroad Gazette* are acknowledged for the loan of a number of the engravings which appear in this report. Figs. 3, 6, 7, 8, 9, 17, 25, 26, 29, 30, 31, 33, 34 were furnished by the *American Engineer*, Figs. 18 and 19 by the *Railroad Gazette*, and Figs. 10 and 12 by the *Railway Age*. The

committee has also received assistance from Mr. T. W. Snow and from a number of members of the Association.

It is impossible to record, in this report, all of the examples of good practice. An attempt has, however been made to show tendencies, as seen in recently constructed roundhouses. G. M. BASFORD.

THE OPERATION OF LOCOMOTIVE TERMINALS, INCLUDING SANDING AND COALING FACILITIES AND THE REGISTERING OF ENGINES IN AND OUT.

Roundhouse organization differs materially on various railways, and also at points on the same railway. However, the average practice seems to be to give the Foreman general charge of all terminal facilities pertaining to the roundhouse and of all the men employed about same; of the engineers and firemen while at the roundhouse, and to hold him responsible for the successful working of the plant. It is not unusual to place the coal-heavers and coal chutes at large terminals under the jurisdiction of the Roadmaster. The Foreman usually has an assistant at points where one hundred or more engines are handled per day, whose duty it is to distribute the work among the mechanics and to see that it is properly done. This relieves the Foreman of a certain amount of the detail, and allows him to devote his time and attention to other things. At smaller houses he distributes all work and gives his attention to all detail. The despatchers, clinker-pit men, wipers, fire-up boys and roundhouse laborers are well taken care of by a foreman or boss, who reports to the Foreman, and works in harmony with the assistant foreman.

This organization leaves the general supervision to the Foreman, and gives him time to devote to the assignment of engines and enginemen, to see that the stores carried in the storeroom are sufficient for the needs, to see that the crews are called in time for their runs, and to closely watch the mechanical detail of the engines, and to exercise his best judgment on what work must be done at once and what may be deferred until another time. It is very essential that all breakages, whether developed on the road or discovered in the roundhouse, should be reported in detail to the Mechanical Engineer, and the Foreman should give this his personal attention. By so doing, the Mechanical Engineer is able to tabulate all breakages, and to strengthen parts that show an unusual number of failures. The Foreman, being on the spot, is enabled to add his opinion of the cause of failure to these reports, which is often of great value to the Mechanical Engineer. On some of the larger roads forms have been printed which give the outline of various parts of a locomotive, such as cylinder heads, piston-spiders, bull-rings, follower-plates, crank-pins, etc., so that it is only necessary to mark with red ink the location of fracture. This is a very excellent plan.

The plan generally followed in handling locomotives at roundhouse terminals is as follows: The engine crews leave engine on in-coming track,

near coal chute. The engineer inspects the engine and makes out his work report. This is made on a form provided for the purpose, and provides for a specific report on the condition of injectors and blow-off cocks, the pressure at which the safety-valve lifts and seats, the train line and main reservoir pressure, and gives space for any other work necessary to be done. Should there be no work required the engineer will so state on a blank, and in all cases deposit same in a lock-box provided for the purpose, to which the Foreman or assistant alone has access. The engineer or fireman then registers in the book provided for the purpose, filling out his name, fireman's name, engine number, train number and time of arrival.

The engine is taken by despatcher and his helper at the point where engine crew left it, and is coaled, sanded, the tank filled with water, and then placed on clinker-pit, where fire is knocked out by helper, while despatcher cleans out front end and clinker-pit man hoes out ash-pan. Engine is then immediately taken into the house. On some roads a blow-off pit is provided, and about two gauges of water blown off before taking it into house.

An engine inspector is usually employed, and at very large roundhouses an assistant, whose duty it is to thoroughly inspect the engine, to go underneath, to tighten up loose nuts and to report all defects to Foreman. Thus a check is made on the engineer, and he is held responsible for all defects not reported. A boilermaker usually goes into the fire-box and does any necessary work before the engine goes out.

When engine is ordered and fired up, it is handled out of the house by the despatcher and helper, tank filled with water if necessary, and soda ash added, wherever used. Any ashes that may have accumulated in the ash-pan may be hoed out at the small ash-pit provided for the purpose, and engine is then placed on out-going track and remains under the care of despatcher until arrival of engine crew.

Modern practice varies with regard to engine crews registering out. Some roads require the engine crews to register out, some to sign a call book when called for the run, and others do not require the crew to register at all, but take their record from the bulletin-board in the roundhouse.

The work slips are handled in numerous ways. It may be said that in general the slips are handed out to the workmen who are to do the work, and in case two or more men are required to do as many classes of work, such as machinists, boilermakers or handymen, duplicate slips are drawn off by the Foreman or assistant and given to each man, who, on the completion of work assigned to him, checks off his part and signs his name on the back of slip and returns to Foreman or assistant, who is thus advised of the completion of the work. A very good plan, which materially reduces the work of the Foreman or assistant in drawing off these duplicate slips, consists in having the engineer's work-report books printed on manifold or carbonized paper. The engineer is then enabled, with but one writing, to make as many copies of his report as will be necessary to distribute to the men who have to do the work. On one of the large rail-

way systems in this country a clerk is provided at each roundhouse, whose duty it is to make out these reports for the engineer. Another plan is to provide a work book in which engineers write their work reports, and from which the Foreman or assistant assigns the work, by marking the initials of the workmen to whom it is assigned opposite to same, and in which workmen check off and sign for that portion of the work they have done. The former method would seem the more desirable, in that the men are not required to go constantly to the work book to see what is assigned to them, and again to check it off, which necessarily consumes a great deal of time. The former method requires more running about for the Foreman or assistant, to keep the men employed, but it keeps the Foreman in touch with the progress of the work, which is certainly desirable. The work slips are filed in pockets provided for each engine, and are usually tied up in bundles at the expiration of six months for future reference.

At times the movement of engines through a roundhouse terminal may be slower than the Master Mechanic thinks necessary. At such places a blank calling for the time of arrival of engine at coal-chute track, cinder-pit, turn-table and time of leaving roundhouse, with such other information as may be desired, may be filled in for each twenty-four hours by the Foreman, and sent daily to the Master Mechanic. This to continue for a week or so, or until an improvement is seen.

At the largest division points, such as the C. M. & St. P. terminal at West Milwaukee, where seven divisions center at one roundhouse, and where there are about eight hundred engineers and firemen running in and out, it is something of a task to keep track of all the men. A cut of the bulletin-board prepared for this purpose is shown in Fig. 41. Also a cut showing the tags to be used in connection with same, which is shown in Fig. 40. The use of the board may be explained as follows: Tag No. 1, if hung in black column or under the head of "Serviceable," would indicate that John White, living at 1001 Thirty-first street, was a serviceable man. In case of Tag. No. 2, it would still hang in black column or under the head of "Serviceable," but would indicate that John White had asked for a rest until 3 P.M. In the case of Tag No. 3, it would hang in the green column under head of "Transferred," and would indicate that John White, for the time being, was temporarily in service on another division. Tag No. 4 would be hung in the red or "not available" column, and would indicate that John White was sick, and had been since the date shown on the card; or, if given a leave of absence, his tag would indicate the date to which his leave of absence was extended. If suspended for any cause his card would also hang in the red column, and indicate the date to which he was suspended. A supply of small cards to be inserted in Tag No. 2 is to be kept on hand near the bulletin-board, showing hours in A.M. and P.M., so that when a man calls for rest the person in charge of the board can, without making a check, immediately provide a card showing the hour

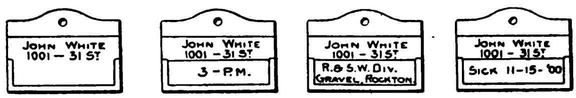


FIG. 40.

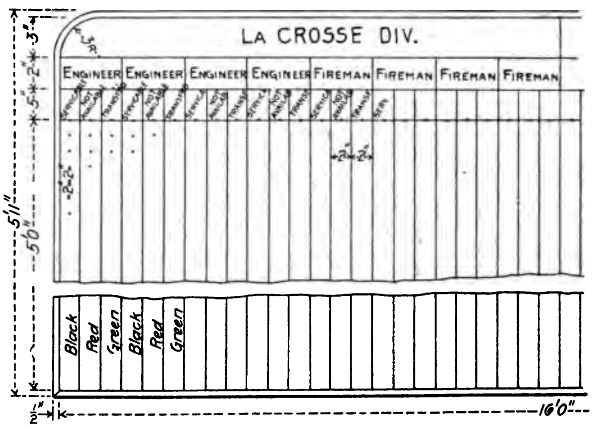


FIG. 41.

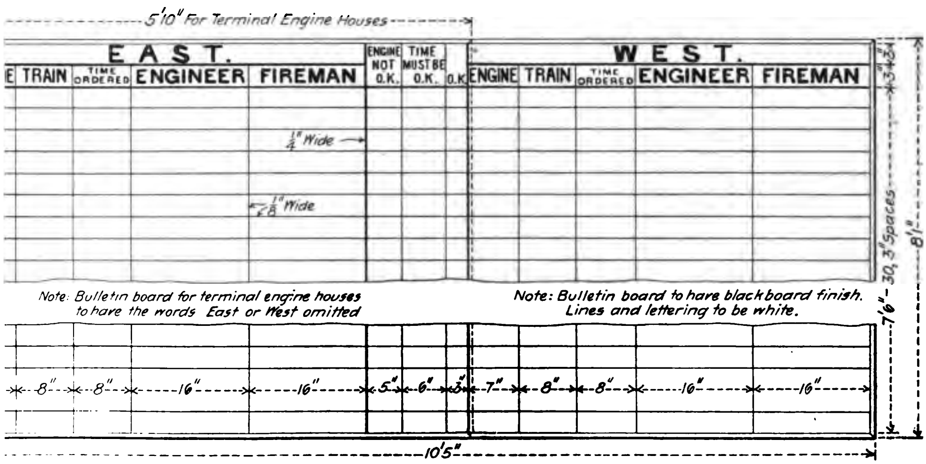


FIG. 42.

to which the rest period extends. The small card is inserted in front of the regular tag.

Another method consists of small blocks being used, on the edge of which are printed the names of the engineers and firemen. The edges are also colored to show if the man be passenger, freight or switch engineer or fireman. These blocks are moved about in cases provided for them, and require very much less space than the bulletin-board described above, and give practically the same results.

Fig. 42 shows a very good example of a bulletin-board for a point where two divisions meet. A column showing the number of the stall in which the engine may be found is an excellent addition to a board of this kind, and will be found very useful in the location of an engine in the house. The despatcher should mark up the stall number opposite the engine number at once after placing engine in the house.

V. B. LANG.

Respectfully submitted,

ROBERT QUAYLE, Chairman,
D. VAN ALSTINE,
V. B. LANG,
G. M. BASFORD,
Committee.

CHICAGO, May 17, 1902.

THE PRESIDENT: Gentlemen, you have heard the report of the committee, as presented in outline by Mr. Van Alstine. What is your pleasure with regard to the report of the committee?

MR. SELEY: I move that the report be received and opened for discussion.

The motion was carried.

THE PRESIDENT: In this report the committee was asked to present plans for up-to-date roundhouses recently constructed, so that we would have as complete information before us as possible of what was going on in different parts of the country. It seems to me that they have done their work in an admirable way and the information contained and the suggestions in the report are well worthy of consideration and worthy of discussion and comment, and I hope some of these matters which I know some of the members have been giving consideration to themselves, will be discussed, also the pros and cons of some of the methods that are being used. The report is before you.

MR. QUEREAU: To start the ball rolling, or to send a goat before the sheep, as they say in the West, I will say something.

The report is very valuable and interesting. It would take a great deal longer to call attention to all the admirable things in it and probably it will result in less benefit than it would to criticize some of the statements made or to propose different plans.

The first matter which attracts my attention is that of the ash pit. I notice Mr. Quayle recommends an ash pit with but one track, and says in discussing this matter that the men who are handling the cinders and cleaning the ash pans of the locomotives, "tell me it is much more desirable for them as well as more economical for the company, to have but one pit and have it of sufficient length to take care of all the engines coming into the roundhouse," etc. I am inclined to disagree with Mr. Quayle in regard to that matter. I am very strongly in favor of a clinker pit with two tracks, with a depressed track for cinder cars between them, for this reason; it will take from twelve to eighteen minutes on an average to take care of a locomotive at the clinker pit. During the busy season, particularly, at points where more districts than one center—the engines for more than one district are cared for—it frequently occurs a number of times a day that there is almost a necessity for running one or more engines around the others. If we have but one track to the roundhouse over the clinker pit, this cannot be done, and it may easily happen that some important train may be held there fifteen minutes to an hour, to get its engine over the clinker pit. If there are two tracks over the pit, this matter is very easily handled. It has been my experience in the West, where there were three districts and the engines were taken care of at one roundhouse, we were frequently blocked and annoyed, and made a great deal of trouble because we could get the engines over the pit only one at a time.

Another matter in connection with clinker pits well worth considering, that is, a track for cinder cars long enough to hold cars for a day's output of ashes. I know that this takes the clinker pit a little distance farther from the roundhouse, but enough can be saved by it to more than pay for this, I believe. If the depressed track will hold only two, three or four cars, it is necessary to hunt up a switch engine two, three, four, five or six times a day and have them come and switch out the cars, get out the ash pit cars and set others in, which causes a delay and expense. If the track for the cinder cars is sufficiently long and properly designed to

hold a day's supply of cars, it is necessary for the engine then to serve that track but once a day. If the location is favorable, and if it is selected with that point in view, it is a very good plan, I think, to have it long enough and the grade such that the day's supply of cars can be on the up-hill side of the ash pit. Then as a car is filled with ashes, it is simply dropped by gravity and another car from above the pit is dropped into its place, and there is no switching of any kind necessary or until it is time to take the loaded cars from the pit.

Another matter which seems to me of some importance, and which if it is mentioned in the report I have not seen it, and that is the location of the ventilators over the track in the roundhouse. I know it is not unusual practice to have these ventilators between the pits. The consequence is that more or less steam escapes from the pops on account of leaking; the steam goes up against the roof, gathers there and drops down, staining the jackets and keeping the roundhouse full of steam. If the ventilator is located over the pops or steam dome over the center of the pit, almost all the steam will be taken from the roundhouse. It will be much more cleanly, the jackets will look in better shape and it will be better in every way.

In connection with the drop pits, which I think everybody will concede is a necessity to a modern roundhouse, I am very strongly impressed that it is economical in every way to have these drop pits cover not less than three tracks, so that the wheels can be dropped from two tracks and the third one left to take them out to the machine shop. One track, while very much better than none at all, is quite awkward, because it causes delays and makes it necessary to either draw the engine off from the drop pit or wheel the drivers over the floor, which is bad.

Mention is made of a pipe about the roundhouse, through which the locomotives can be blown off, that is, the steam pressure reduced. If I remember, the largest diameter of pipe mentioned for this purpose is five inches. I will be glad to know if any experiments have been made to determine how long it takes to blow off an engine through a five-inch pipe, compared to allowing the steam to escape in the open air. I thought at one time we were doing a great deal when we put up a four-inch pipe in the roundhouse for blowing off steam, but I found it was a waste of

time and money, because it delayed the blowing off of the engines so much. It took us so much longer to reduce the pressure through a four-inch pipe than when the steam was allowed to escape out of doors. I think it was inadequate for that service. If there are any figures on that point, I think they would be of interest to the members of the Association.

In connection with the drainage of the pits, I am impressed that it is much better practice to allow the water to run away at the sides of the pit instead of in the center. Although it may be run off, on paper, with the gutter in the center, we all know that the concrete work and flooring work is not of the best and does not conform to the slopes and smoothness of the plans, and there is always more or less water standing in puddles or pools where the drainage is in the center of the pit. If it is at the side, it will at least drain off the part of the floor used by the machinist, making it much more comfortable and better.

In connection with the sand house, as I understand, the plans submitted by the committee contemplate unloading the sand onto the ground floor of the sand drying house. The plans from there on are very complete and labor saving, in that the sand is elevated by compressed air and delivered to locomotives much as water is. It occurs to me that it would make the plan much more complete and economical if the sand was loaded from the end of the coal trestle into a bin above the stoves. Mr. Van Alstine tells me that it is, but I did not so understand the wording of the plans. I have in mind one such plant, where one man takes care of all the sand for an entire division, for, I presume, something like 90 to 100 locomotives. The sand is shoveled from the car at the end of the coal trestle into an elevated bin from where it drops by gravity about the stove pipe and as it dries it drops over a funnel which conducts it into a reservoir, and there is no manual labor, except in turning the air pressure on this reservoir which lifts it up again to the point from which it came, although, of course, to another bin.

I had something to say last year about the organization and systematizing of the forces in a roundhouse, and at the expense of being accused of riding a hobby, I want to call attention to it again—not the particular plan to which I referred, but to the importance of organization and system. To my mind that is more

vital than the arrangement of the roundhouse itself. I have in mind a roundhouse in which the roundhouse board has a number of extra columns, and by extra columns I mean such as are not on the usual roundhouse board, and not shown in any of the samples I find on page 43 of the report. There is a column on which the call boy makes his mark when he has called the engineer and fireman. There is a column on which the machinist makes his mark, indicating his work is done on the engine opposite this mark. And so there are various columns for the different branches of work necessary to be done to a locomotive before it is ready for service. The consequence is that the roundhouse foreman can be seen most of the time standing in the circle with his hands in his pockets apparently doing nothing, and yet if you will ask him when such and such an engine will be ready he can tell you at once, simply because the roundhouse board tells him from observations made at intervals how the work is progressing on each of the locomotives. One of the details in this system is very interesting and is a fair sample of all the rest. As soon as the flue man has inspected the flues of an engine and has put the fire box in good shape, he puts a circle on the inside of the fire door. The fire lighter coming around to get the engine ready for service does not have to hunt up the boiler man or the roundhouse foreman or anybody else. He simply looks at the door. If the flue man's mark is there he knows that locomotive is ready to be fired. You can easily see when a system of that kind is carried out in detail, as it is in some places, and can be in any place, the large amount of time which is saved, the greater information which everybody has, and the greater certainty of operation. When the engine is under steam at this roundhouse a mark is also put upon the board opposite the number of that engine, so that you can readily see that any one interested, the roundhouse foreman or his assistant, or the shop foreman, the master mechanic, or any one else, can tell from the roundhouse board the condition of the engine and what work has been done upon it and what work has not been done.

In connection with this system as worked out at this point, there is a board called the "wash-out board" on the incoming track which the hostlers can easily see, as they take the engine on the turn-table. On that board is put the numbers of the engines which are to receive a washing out that day, that is, before they go

out again. Accordingly the hostlers place the engine where it can be washed out to the best advantage. Instead of putting them in the circle they are put on the pit where they can be served. If not to be washed out that trip, he puts them out on the storage track or anywhere else. That is another illustration of the importance of system and organization.

I also think it is quite important that the organization be extended to the hostlers who bring the engines from the yard, coal them up, give them water, and take them from the turn-table. A system that is working very successfully is to have two sets of hostlers, each hostler having a helper. That is at a point where they care for a large number of engines in the course of the day. One set of hostlers bring the locomotives from the yard to the coal chute, give them coal, sand and water, and deliver the locomotive at the clinker pit. Another set of hostlers handle the locomotives on the clinker pit, across the turn-table, and into the roundhouse. By this division of the duties of the hostlers, the system works to perfection. There is the least possible loss of time under this plan and the work is done in the most satisfactory manner. The hostlers who take the engines from the yard are in touch with the yard office, so they will know what trains are coming in. In fact it is another illustration of the modern tendency to specialization, and with a roundhouse of any size I know it would pay.

One more feature, and that is the system of distributing work through the roundhouse. Personally, I am in favor of the use of work slips, whether the engineer reports his work on a slip or on a book; and I believe the work slips should be distributed by the roundhouse foreman or whoever is in charge of the repairs to the locomotive, such as the assistant foreman, or foreman of the machine shop; I believe in these heads of departments distributing the slips personally. The committee seemed to think it might require some time, more than desirable, possibly, if these slips were drawn off, but I have found that the call boys can very easily do this work, putting one job or piece of work on a single slip. The call boys, when they first come to work in the morning or when there is the first lull in business, will copy the work book or slips handed in by the engineers, and hand them over to the roundhouse foreman or his assistant. He personally distributes these slips to the men who are to do the work, giving the work to such

men as are competent to handle it and can do it for the least money. After the work is done the man who is responsible for the job signs his name on the slip. They are turned into the roundhouse foreman's office, and the work checked off on the books. This system puts the man who is in charge of the repair work in close touch with all of the work to be done on the locomotives. He is in a position to judge as to what can be allowed to go for a time or what work must be done immediately, and not only keeps in touch with the work but with the abilities and dispositions of the men who do the work.

MR. W. O. THOMPSON: After reading the very able paper which has been presented, and listening to Mr. Quereau's remarks upon the same, there is not very much left for any of us to say. However, with reference to the drop pits, in my opinion, instead of having the drop pits extending out so far as three or four stalls, as mentioned in some places in this paper, it seems to me it would be better perhaps to have two sets of drop pits, one for the drivers, and another in some other part of the house for the engine and tender truck wheels. Usually your drop pits, particularly in large engine houses, are filled up nearly all the time, and if you have your drop pits off somewhere else for engine and tender trucks, that will facilitate matters and save time.

As to the blowing off of engines, my experience has been that about the ideal way is to have a good sized pipe running along on the roundhouse floor, or immediately below it in front of the engines and having branch pipes leading from that pipe, with flexible ends so as to attach the branch pipes to the blow-off cocks. When the engine is blown off, you are then ready to wash out.

Mr. Quereau's remarks as to the desirability of having two sets of hostlers, one set bringing the engine to the cinder pit and the other set taking the engine from the cinder pit to the house, in my opinion, that would depend largely on conditions. The general practice nowadays, in our modern roundhouses, is to have a track designated for the giving up of engines, such as the cinder track. In that case, I believe time could be saved by letting the hostler clean the fire, as practiced in a good many places, and letting him stay with the engine until he gets to the house. Then there is no swapping around, waiting for some other hostler to come and get

the engine. In regard to stand pipes, I notice that in many cases they have only one pipe, and that is at the far end of the cinder pit. It seems to me that the stand pipe should be between the cinder pit and the turn-table of the roundhouse.

I do not believe that I have anything more to say with regard to this report, but I will suggest, while on my feet, that Mr. George W. Wildin, of the Central Railroad of New Jersey, who represents the Traveling Engineers' Association at this convention, is present, and it is possible he might have something to say.

THE PRESIDENT: We will be pleased to have the gentleman take part in the discussions. We are glad to welcome him at our convention.

MR. WILDIN: I thank you for your kindness and if an opportunity should arise I will be pleased to participate in the discussions of the convention.

THE PRESIDENT: I believe you are a member of this Association.

MR. WILDIN: I am.

MR. F. F. GAINES: I fully agree in all that has been said regarding the wooden smoke jacks lined with lead. I would like to ask the members of the Association if they have found them charred under this lead lining? A question has been raised by a number of underwriters as to their use in the roundhouse. That question has come up, and objection has been raised to them on the ground that they are not safe, or at least the insurance underwriters object to their use.

Now in connection with the sand stove and sand-drying arrangements, there are several arrangements for drying sand by both steam and stove, but I do not see any mention made of the fact which has been brought forward recently, that the use of a stove in drying sand burns it and dries out the water of crystallization and the sand when so dried loses a great deal of its abrasive properties.

MR. E. A. MILLER: I would say in regard to wooden smoke jacks, that our experience with them has hardly been satisfactory. We have had a number of cases on each of our roundhouses,

where the wooden jacks are used, of their taking fire. It is very inconvenient, especially if the slate roof is covered with ice in the winter time, to get up and extinguish these fires. I would not like to recommend the wooden smoke jack as being the best thing for a roundhouse.

In regard to the sand, we use a locomotive boiler for heating water for the washing out of locomotive boilers in the roundhouse, and have connected to the front end of the smoke box of this boiler a sheet-iron cylinder with boiler tubes through which the smoke and heat pass. This cylinder has a hopper on top. The sand is shoveled into that hopper from bins and as it passes down through between the tubes it is thoroughly dried from the heat of the water boiler, so that we are saved the expense of fuel and the keeping up of stoves for sand drying. This has been very successful in supplying sand for the out-going of sixty to seventy engines in the twenty-four hours. The sand in passing through this boiler drops into a sand reservoir and from there is carried by compressed air into a tub and supplied to the locomotives by gravity. We have found this very economical and very satisfactory, and the sand in no cases is overheated or burned, as is often the case when stoves are used.

MR. W. D. ROBB: In the equipment of a modern roundhouse the sand should be located at the end of the coal chute, and the ash pit a short distance from the sand house, and not more than 200 or 250 feet from the pit of the shop turn-table. The drying of the sand for a large terminal can be taken care of by the coal men or by the ash pit men in addition to their other duties. We have been drying sand by steam, but it is not a success—at least we have not found it so. We have found that to get sand properly dried so that it will not clog or cake in the box, it is necessary to heat it by a stove and burn it. The sand should be blown up by air, as stated by a gentleman previously, and delivered at the end of the coal chute, the same as the water.

I do not agree with the statements in respect to depressed pits. I do agree, however, that two ash pits for a large terminal are better than one, for the reason that it may be necessary to get certain engines into the shop quicker than others and it saves running one engine around another; but instead of a depressed pit the cinders

should be dropped into a bucket and hoisted with an overhead hoist, and put into the ash car. When this is done the ash pits do not require to be longer than 30 or 35 feet. The ash car storage track should be long enough to accommodate a sufficient number of cars to take care of the cinders for twenty-four hours or longer.

I have not noticed mention made of all the appliances for washing out. The practice on the Grand Trunk System is this: no steam or water is allowed to be blown into the shop and no water is allowed to run into the pits. Outside of each shop there is at least one tank with a partition, and these tanks hold from 8,000 to 12,000 gallons or more, depending on the size of the terminals. There is an underground pipe connected with the blow-off cock which runs the water into these tanks. There is an overhead pipe that takes the steam to the tanks. As soon as the steam of the engine is blown out and the water blown off, the plugs are then taken out and the washing operation commences. The water for washing out is drawn from that section of the tank which receives the hot water from the boiler and is regulated as hot as the washer-out can handle it. After the engine has been washed out the boiler is filled up from the tank which received the steam from the boiler, where the water is cleaner. I may qualify that by saying that one section of the tank takes the water from the boiler; the other section of the tank takes the steam from the boiler. The water in the latter section is perfectly clean and can be put into the boiler at a much higher temperature than a man can handle it in washing out, and steam is obtained in a very short time after the engine has been fired up. We wash out entirely with a pump. In addition to having the steam pipe going around the shop for the purpose of blowing steam into the tank, there should also be connections made with the engine, so that advantage can be taken of the steam of an incoming engine to assist an outgoing engine. The steam from the incoming engine can also be used for putting on the blower, etc., to help an engine going out. In addition to the steam being put in the tank from the boilers all of the exhaust from the pumps, stationary engines and steam pipe condensations can be returned to these hot water tanks. The stationary or heating boilers in the shop should also be fed from the same hot water tanks by a small feed pump putting the water through a superheater before it enters the boilers, the exhaust from the

different stationary engines, pumps, etc., being used for this superheater before going into the tanks.

MR. F. M. WHYTE: I would ask the gentleman how long it takes to blow down an engine when he uses the steam from one boiler to "blow up" the steam pressure of another boiler, and also when blowing the steam into the tank? How long does it take to blow down the pressure from the locomotive boiler, either blowing into the tank or into the blower pipe of another locomotive boiler?

MR. ROBB: I will not say how long it takes to blow from one engine to another, but we can take an engine into the shop and wash it out thoroughly in three hours.

MR. WHYTE: How many wash-out plugs have to be taken out?

MR. ROBB: We have a large number. There are four in the corners, two in each of the side sheets, two in the face plate, and two in the bottom of the smoke box; also two in each side of the saddle or top plate of outside fire box.

MR. G. W. WEST: None of the speakers have told us whether they blow the boilers out under pressure, or allow the steam to be reduced. This point has much to do with the character of water or steam taken from the engine, in connection with the character of the roundhouse, and it would be interesting if the speakers will advise us whether they blow the boilers out under pressure or after the pressure is reduced.

MR. ROBB: We blow the steam into the tank until the pressure is reduced to about twenty pounds in the engine and then at that pressure we blow the water into the tank.

MR. WILDIN: I would ask the gentleman what size pipe he uses in connection with the roundhouse for blowing off the engines? I understand you have one pipe for water and one for steam?

MR. ROBB: We use a three-inch pipe in both cases.

MR. ANGUS SINCLAIR: I have been on record quite a number of times against the practice of blowing off boilers when the engine is hot. Those who are familiar with the formation of scale in the boiler are aware that you can count the strata in the scales in the boiler, which shows the number of times that the boiler has

been blown off. A great quantity of the impurities coming from the water floats on the surface of the water in the boiler, and when the boiler is blown off hot, the scale-making matter settles upon the heating surfaces and becomes hard scale that cannot afterwards be washed out. That is not a theory, but a fact gained from observation, with which the men accustomed to hard water districts are familiar. I know the Association has urged repeatedly that no engine should be blown off while it is hot, that is, it has been recommended that the steam be blown off and that the boilers be gradually filled up with water, and that the reduction of temperature should be obtained as slowly as possible. Every one knows that treatment of that sort is liable to be easier on the sheets than if the boilers are blown off hot, especially when a hot brick arch is used which takes a long time to cool down, and it seems that the brick arch does a great deal of injury to the side sheets when a boiler is cooled down so rapidly as it is when it is blown off with steam and hot water together. It is well known that in the navy great care is exercised in the raising of steam with boilers, for the reason that very serious injuries to the heating surfaces sometimes ensue. In locomotive practice the boiler is subjected to the same process, of course, and it seems desirable that we should hold onto the previous recommendation of boilers being cooled down gradually.

In regard to what Mr. Gaines said about the sand, I have had considerable experience with sand, and it is a long time ago since I investigated why it was that certain sand which was apparently very well dried, would become moist after it was in the sand box. The reason of it, no doubt, is that there is the moisture of crystallization in it which can only be taken out by burning. There is also sometimes moisture connected with saline matter, where salt or soda has been in the ground and that will often make the sand wet after it is in the sand box. Where the sand is roasted, so to speak, that water of crystallization is roasted out and you will scarcely ever have any trouble with wet sand in the sand box when that process is followed.

MR. WHYTE: I would like to ask some of the members who have had experience with hot wells, whether they find it possible to conduct all the steam from locomotive boilers into the hot well, or whether it is true that the water in the hot well becomes so hot

that the wash-out men cannot handle the nozzle of the hose and the steam must be directed to the atmosphere from the locomotive boilers?

MR. J. CHRISTOPHER: I would ask Mr. Robb if it is his practice to use the pressure from an incoming engine attached to the blower pipe of the engines being fired up after washing. Does his experience lead him to believe it is good practice? Does increasing the heat in that rapid manner give the sheets time to assimilate it? Is it not equally injurious to a boiler to heat up too rapidly as well as to cool down too rapidly? I understand he attaches the steam blower pipe to his engine which has just been washed out, to facilitate getting up steam quickly. I ask him if I am not correct in assuming that there is some danger of injury to the sheets in this practice?

MR. ROBB: I may say in answer to Mr. Whyte, who raised the question about the temperature of the water, that the water in the hot well does undoubtedly get so hot that the men cannot handle it, but in addition to blowing hot water into the tank we have the cold water supplied from the main water pipe to the tank, and also have cold water connections to the suction pipe of the pump, so we can regulate the temperature of the water, and the washer-out gets the water at a temperature at which he can handle it.

With regard to the question of Mr. Christopher, the auxiliary blower pipe can also be attached to the blow-back steam pipe. The blower can be used that way or attached to the injector steam pipe or other boiler connection, and steam can be put right into the boiler, using the engine blower the same as under ordinary circumstances. When starting to wash out and when blowing back steam and water to the hot water tanks, the smoke-box and fire-box doors are kept closed, the object being to keep the boiler as hot as possible from start to finish. The smoke-box door is opened only a sufficient time to wash out the bottom of barrel of boiler. We have been using hot water in washing out for eighteen years. Previously we washed out with cold water—running the water through the boiler, opening the blow-off cock and letting it run through so many hours so as to get the boiler cold before you washed it. At the present day the exigencies of the service will not allow that to be done, as it is invariably the case

that the engines have to be gotten out in a hurry; and I have yet to find, after eighteen years' experience, any injurious effects from washing out engines with hot water. Of course, it is necessary to see that the washer-out does not open the engine up and wash out with cold water, when he should be using hot water.

MR. R. V. WRIGHT: Under the heading of "Blow-off and Wash-out Piping" the statement is made that air and steam blow-off pipes are run overhead without serious inconvenience. Where these steam blow-off pipes are run overhead, is it not desirable to have them covered? The moisture gathers and drops down and causes serious inconvenience. I would ask if any of the gentlemen have covered them and with what result?

MR. WILLIAM MCINTOSH: In answer to Mr. Wright's inquiry, I would say that in my experience it would be advisable to cover the pipes, as otherwise considerable moisture will gather on them.

With reference to what Mr. Sinclair has said about scale forming, when steam is blown off from the boiler, I am quite confident that occurs. I have had experience in bad water regions in repairing boilers and removing flues, or a portion of them, by pulling them out through the front sheet, and found when we did that that it was advisable to allow the boiler to cool down entirely, and then we could wash it out and clean the flues without difficulty. In this way we could get the incrusting matter soft and readily clean it from the tubes, but if, on the other hand, we blew the steam and water from the boiler when it was hot, it would be impossible to pull out the flues, even with a winch.

MR. F. M. WHYTE: Figure 35 shows, I believe, the attachments that are used by the Chicago, Milwaukee & St. Paul R'y at West Milwaukee. These connections are made down near the side of the pit; they have no overhead pipe, therefore the water is forced out before the steam is allowed to escape. If any one from that road is here, I would ask if they have found any difficulty with the formation of scale on the tubes and side sheets due to this manipulation? They have as bad water as almost any road that we know of.

MR. L. R. POMEROY: During frequent visits to the West Mil-

waukee shops of the C. M. & St. P. R'y, I noticed they made a practice of blowing off the boilers of locomotives immediately after giving up their trains and just before they were placed in the roundhouse, the idea being to blow off all the floating impurities possible while soft and plastic and before settling down on the heating surfaces and becoming hard and solid.

MR. E. A. MILLER: We all realize the importance of avoiding delay as much as possible in the washing out of boilers. Our practice is to open the blow-off cock, when the boiler is to be washed out, before the engine goes into the house, and from the blow-off cock blow out the water and carry off in that way as much of the sediment as is possible. We find in the frequent blowing off of boilers that we carry away a great deal of loose sediment; and in order to avoid the accumulation in the boilers of mud and sediment we have put blow-off cocks on our locomotives. So that the boilers can be blown out at the terminals at the close of each trip. While Mr. Sinclair's theory is correct, as to the hardening of the scale by blowing off the water and steam, it is a fact that where the water is taken largely from streams, the sediment and mud accumulating in the boiler is harder to take care of than the scale that forms where the water is no worse than that which we have to contend with on our division. We blow off the boiler before putting it into the roundhouse and then let it stand for two hours, by which time it is pretty well cooled down, then we start in a stream of hot water from our heating boiler and wash out with water as hot as can be used, without detriment to the men who wash out the boilers. In this way we have very little trouble and find no serious accumulation of scale on our tubes and sheets.

PROF. HIBBARD: I have had occasion during the past year to examine a good many blue prints of new roundhouses and to visit a good many new and old roundhouses. Just the one point I would like to bring forth at this moment which has greatly impressed me in these visits and examinations, is the question of *daylight lighting*. I looked through this paper with considerable care to see what was said with regard to daylight lighting, and I find almost nothing. I know that the glass in the mansard roof of the Pittsburg & Lake Erie Railroad, at McKee's Rocks, has been spoken of; and I am inclined to think from my

observation that perhaps that roundhouse may be one of the best daylight roundhouses in the country.

If one examines the recent cotton mill construction and recent machine shop construction, he will find that very great attention is paid to this question of letting in ample daylight. The exterior walls are made almost completely of glass, with just as little stone, brick or steel column support as may be necessary to carry the upper floors and the roof. The windows extend from bench height to ceiling, sometimes with factory ribbed glass to catch the more vertical rays of light and bend them in horizontally into the room. Particularly is this glass adapted if the room extends a long distance in from the windows, or is lighted from one side or end only, or is near other buildings which prevent a low sky line. So far as I know there is not a single roundhouse in this country that carries out this idea of having the greatest possible amount of daylight admitted through the exterior walls. They will put windows in the walls, but there is a great amount of brick obstruction between windows. I have noticed that in a wealthy road's very large, new, roundhouse that is not yet completed. I said to the master mechanic of the division, "Are you going to have light enough here?" He said, "To tell the truth, we are not. I wish we could design this roundhouse over again." I said, "I believe this ought to be an axiom in the designing of roundhouses, namely, that you cannot get too much daylight into them." If I could leave one thought as a contribution to this discussion on roundhouses, it would be — get all the daylight into them that can possibly be obtained.

MR. ROBB: There are two points which I omitted to mention when discussing this subject. One is the ventilators. I do not consider that ventilators are required in a modern roundhouse at all. If care is taken of the steam and water as I have mentioned it will be found that ventilators are not necessary. The last new roundhouse erected on the Grand Trunk Railway had no ventilators, and we have found it to be satisfactory without them.

The other point is the wooden jack. We have had the wooden jack in service for something like 25 years, and I fail to call to mind a wooden jack ever having been on fire. The jacks we put

in are painted and sanded inside. We use the wooden jack above the roof only, iron or steel drop jacks being used below.

MR. W. O. THOMPSON: In regard to Prof. Hibbard's remarks about lighting roundhouses, I agree with him exactly that you cannot get too much light in the roundhouse. My opinion, however, is that it should be confined exclusively to the roundhouse walls. When you put lights in a roundhouse roof, or up over the engine house doors, as is done in some places, and you will go around in a month or two after the roundhouse is completed, you will find all this glass is covered with dirt, doing away with all the light that formerly came from it. I think, however, it is advisable to have as many windows in the walls as can be without weakening the walls.

MR. M. N. FORNEY: I would add my testimony to that of Prof. Hibbard's in regard to the general question of daylight in shops. In past years, I have had occasion to travel through the country and visit railroad shops in many places, and it seems as if their designers always took the greatest pains to exclude daylight. It may be laid down as an axiom, that in roundhouses or workshops of any kind, wherever men are employed, that you cannot admit too much daylight provided you can exclude the sunshine. Of course, in hot weather the sunshine is objectionable. The largest possible amount of window area is important, and furthermore you will find very often that the architect, or the person who designed the shop took pains to exclude the light from the upper portion of the building. As a matter of fact, if you go into the studio of an artist, where light is of importance, you will find that he always takes pains to carry the window as high and as near to the ceiling as possible and excludes light from the lower portion of the window. The light from the top is more desirable to work in than that which comes from the lower part. Therefore, there are two principles which may be laid down without hesitation, and that is to get the largest possible window area in the walls, and the other is to carry the windows up as close to the ceiling as possible.

MR. T. A. LAWES: I submitted to the committee on up-to-date roundhouses last year a plan of a roundhouse in which the outer wall was all glass and steel. The roof trusses were supported on

I-beam columns, and in the interval between each I-beam column the space was filled with glass, no brick in it. The committee did not see fit to publish this design, and I presume that it was considered to be somewhat visionary; but the time will come some day when there will be no brick walls in the outside circle of roundhouses; they will be steel and glass.

MR. McINTOSH: The company that I am connected with, the Central Railroad of New Jersey, has built two roundhouses during the past eighteen months, and in both we have arranged to do just what has been suggested as desirable, that is, provide as much light in the outer walls as possible. We secured a very good proportion, and I should say that nearly 35 per cent. of the wall is glass.

MR. F. M. WHYTE: I would like to bring the convention back to the question of blowing off locomotive boilers.

THE PRESIDENT: Are there any remarks to be made with regard to the blowing off of locomotive boilers as suggested by Mr. Whyte?

MR. QUEREAU: As to the matter of time to blow off a boiler I will say that a 60 to 62 inch boiler can be blown off out of doors through a one and three-quarter inch pipe in thirty-five minutes, down to twenty or thirty pounds pressure, at which time the pressure is supposed to be sufficiently low to fill the boiler with cold water.

MR. WHYTE: How will that compare with the blow-off pipe, three, four or five inches in diameter?

MR. QUEREAU: I cannot say how that will compare with the blow-off pipe of three, four or five inches diameter, except in one case, that of a four-inch pipe, to which I alluded, the length of time to blow off was lengthened from fifteen to twenty minutes compared with the time required to blow off out doors. We had to abandon it during the rush. I would like to know how it would be with a five-inch pipe?

THE PRESIDENT: Mr. G. M. Basford, one of the members of the committee, has not been heard from. Perhaps he would like to add something on behalf of the committee, to what has been said.

Mr. Basford: Thus far there has been nothing said in the discussion with reference to the importance of the up-to-date roundhouse as part of the railroad equipment. It was not so long ago that almost anything would do that would house the engines. That seemed to be the main function of the roundhouse. That is no longer the case, and at the present time the very best and most complete equipment possible is absolutely necessary. The correspondence before the committee has indicated a very general interest in this subject that reaches very far beyond the mechanical men alone, and in answer to requests for information a number of gentlemen, principally among the chief engineers of the different railroads, have asked to have copies of the report sent to them. These gentlemen seem to desire to know what the motive power requirements in the roundhouse are. They seem to realize that it is not alone a question of buildings, of walls, of floors, of windows and doors and turn-tables, and that the "roundhouse" of to-day is not merely a building but a whole locomotive terminal. This is a promising indication in connection with the construction of roundhouses and an indication of the opportunity which this Association has to coöperate with the other departments of the railroads in connection with subjects of this character. It seems important that this point should be made in connection with the discussion, because at the present time when an appropriation is made for a roundhouse it has to be a large one, and it seems to me that the higher officers of the road should appreciate the necessity for a large appropriation.

Mr. E. W. Pratt: The remarks in regard to lighting and ventilating interest me. In regard to the lighting, I would say that it seems as though a large proportion of the new roundhouses under construction are building in the western portions of the country, where the railroad terminal facilities have been growing and have outgrown the crude structures which were originally erected. In many of these houses, when they were first built on the prairie, at some distance from other buildings, there seemed to be ample light from the outer walls. A few years later the various shop buildings sprung up around them and the light that was first admitted from the outer walls was gradually excluded. While the remarks made by one member that the light through the sky-

lights was likely to be obscured, if the glass is not clean, is, in a measure, true, yet it is a fact that we are not likely, with skylights, to lose the lighting effect by subsequent buildings, and proper respect for cleanliness will do the rest.

As to the ventilator problem, I am very much inclined to think that where bituminous coal is used, the ventilators cannot be used. It has been found, in hurrying up large locomotives for their runs, the engines back out of the house and emit a large volume of dense smoke, even if the jacks are perfect, from the time the jack is raised until the engine stack clears the house, and in this way a great deal of smoke is allowed to escape into the roundhouse.

A remark was made with regard to washing locomotives immediately after they were blown out or as soon as they got cool. To this I cannot agree. The experience that I have had in a poor water district is that when a locomotive is brought in for dropping the wheels, or some work that would not require any boiler work, it is of considerable advantage to blow the boiler out, and two, three or four days later, when the engine is ready to leave the shop, to give the boiler a good washing out. It seemed peculiar to me at first, but the facts pointed that we could get three or four wheelbarrows of scale from washing these engines out after they had been dry for several days, that we could not remove upon the immediate washing out of the wet boiler when the engines first came in.

MR. C. A. SELEY: This is an important question, and we have taken a great deal of time. I would suggest, in view of other important papers, that the discussion be closed, and that any further information which the members desire to impart, should be contributed in written form to the committee which presents this paper, and that these discussions be placed in the Proceedings in regular order.

The motion was carried.

MR. M. N. FORNEY: I was not present at the opening of the meeting to-day, when new business was in order, and I would like permission to introduce a resolution at this stage of the proceedings. It is as follows:

Resolved, That the Master Mechanics' and Master Car Builders' Associations have met in Saratoga oftener than in any other place, and it

has been found that its location, climate, waters, hotels, and other attractions make it in many ways a most desirable place to meet in. There is, however, one great deficiency here — there is no room in Saratoga whose size, location, arrangement and acoustic properties are suitable for holding such meetings.

Therefore, by the passage of this resolution, it is desired to call the attention of the citizens and hotel proprietors of Saratoga to the need of such a room, and to express as the sense of this Association that until a suitable place of meeting is provided it will be inadvisable to come here again. The secretary of this Association is hereby instructed to send a copy of this resolution to the proprietors of the Grand Union and United States hotels, and, if possible, to secure its publication in one or more Saratoga papers.

The resolution was unanimously carried.

THE PRESIDENT: There is one subject on the programme yesterday which was partly considered and which was left over for consideration to-day in the expectation that we would receive a communication from Mr. F. A. Delano, chairman of the committee last year, on the cost of running trains at high speed. I understand the communication has not been received, and the matter is before you if there is any further discussion. Mr. Clark, have you anything to say with regard to the subject further? If there is no further discussion a motion to close the discussion on this subject will be in order, and that will dispose of it finally.

MR. McINTOSH: I just want to point out, before discussion on the subject is closed, that the results of the test mentioned in the appendix show an increase of about 50 per cent. horse-power to move the fast trains. An increase in average pounds of water of about 25 per cent., and an increase in the average pounds of coal of about 20 per cent. per ton-mile is also shown. The difference between the coal and water can be accounted for by the fireman allowing his fire to run down somewhat when closing the last run.

PROF. HIBBARD: I move that the discussion on the subject be closed.

MR. E. W. PRATT: Would it be in order to amend the motion by allowing the remarks of Mr. Delano to be handed to the Secretary and printed?

PROF. HIBBARD: I accept the amendment.

The motion as amended was carried.

F. A. Delano (*Communicated*):

My only reason for accepting the invitation of the American Railway Master Mechanics' Association to be heard again on the subject of running trains at high speed is that there seems to be, through lack of interest, or some other cause, very little said by those who are competent to speak, and who could throw useful light on this subject. From the start, the discussion on this subject has been confused as between the question *whether high speed pays* and the question of *what high speed costs*—obviously two very different and distinct questions.

Two prominent trunk lines between Chicago and New York have recently put on trains to make the distance in twenty hours; each of these trunk lines express their willingness to make the distance in eighteen or even sixteen hours. These trains start from Chicago equipped with powerful engines hauling four cars including the dining car. It is not for me to say that such trains do not pay; that question is for the officers of the companies concerned. The question which as an engineer I am concerned with is what it costs to operate such trains taking all phases of the problem into consideration.

In a sworn statement before the Senate and House Committee on Postal Service, when urged to make an estimate or give an expression of opinion as to the cost of running trains at high speed, I stated that while I ventured only a guess based on very insufficient data, I thought the cost of operating trains at speed increased in a greater ratio than the speed, and in a ratio amounting to perhaps 1½ times the speed. The more I thought about the question and studied the evidence, the more I have come to the conclusion that this statement was no exaggeration.

I shall not attempt to rehearse at the present time the analysis of the subject which was made in my original paper to the Western Railway Club, subsequently referred to the American Railway Master Mechanics' Association for discussion, but there are some phases of the subject which a better opportunity for studying has enabled me to appreciate more fully. Many railroads have spent immense sums of money for reducing curvature, simply to make high speed possible, and in such cases high speed service should bear a very large share of the interest on this expense. I know a valley line, about 25 per cent. of which is curvature; the curves are generally from 3 to 5 degrees, and with trains running up to 35 or 40 miles per hour were never considered objectionable. Furthermore, as the grades of the line are excellent, for freight traffic this line could not be excelled. The acceleration of some passenger trains, however, to 45 or 50 miles per hour on this valley line at once demonstrated that the curvature must be greatly reduced, and to bring the line up to possibilities for trains scheduled at from 50 to 60 miles per hour, inclusive of stops, would necessitate an expenditure of millions of dollars.

In my original paper I dwelt at some length on the interference to freight traffic and other slow speed traffic on account of high speed trains. New light I have gotten on this subject makes me venture the following

assertion based partly on estimates. Given a single track railroad of water grade:

A large volume of coarse freight traffic amounting to say 150,000 tons per track mile per month, chiefly in one direction, or of nearly double this if the traffic is evenly balanced, could be readily handled, providing there was little or no passenger traffic to interfere with it. The number of passing tracks, and the length of these passing tracks would not have to be very great, and the "factory" cost,—(to use the political economists' expression)—of doing this work, would not exceed 15 mills per ton mile. If on this railroad with this amount of traffic it was attempted to add one, two or more passenger trains, the effect would be immediate; first, in the detention of the freight trains, which would cause a congestion and prevent the normal movement, and we would immediately require long passing tracks so that passenger trains might meet and pass freight trains.

I venture the assertion that the capacity of the railroad would at once be diminished and the cost of doing business would at once be increased on the entire freight tonnage handled by not less than 20 or 25 per cent. If several high speed trains were run the capacity of the road would be so far curtailed that double-tracking would probably be necessary for a greater part of the line.

Without further argument I submit that either my statements are very wide of the mark, in which case they should be challenged, or else that it is high time that railway managers and engineers, both mechanical and civil, should consider this subject.

The belt conveyor in handling materials represents the continuous forward movement of material, and the amount carried by any given conveyor is proportionate to the speed. The more nearly railway train service in handling tonnage over a railroad approximates the conditions of the belt conveyer in carrying material, the more economical will the work be done.

THE PRESIDENT: We will now take up the report of the committee on "Present Improvements in Boiler Design and Best Proportions of Heating and Grate Surfaces for Different Kinds of Coal." The paper will be presented by Mr. George W. West, chairman of the committee.

MR. WEST: In harmony with one of President Waitt's suggestions that papers be referred to individual members for preparation, and in order that credit may be given to whom credit is due, and in the absence of Mr. T. W. Demarest, and after conference with Mr. H. D. Taylor, the committee decided that it would be advisable that Mr. Gaines, who has prepared all the data, and who has contributed about all the labor that has been expended on the report, should present the report to the convention, and I would

ask Mr. F. F. Gaines of the Lehigh Valley Railroad to read the paper.

MR. GAINES: I have had my attention called to the omission of some of the recent engines in this paper. I am sorry for it, and my only excuse is that no person could go over the technical papers for several years past without the risk of overlooking a few engines that ought to be included. I also find that while provision is made to incorporate the ratio between indicated horsepower and grate surface, and while the ratios are given for the individual engines, no curves or data sheets were plotted. This is being looked after, and with the permission of the convention they will be forwarded to the Secretary and incorporated in the final report when printed. This report has been prepared as a committee report, and as at this time I cannot change it to an individual report, I will read it as it has been presented to the convention.

Mr. Gaines read the following report:

REPORT OF COMMITTEE ON PRESENT IMPROVEMENTS IN BOILER DESIGN AND BEST PROPORTIONS OF HEATING AND GRATE SURFACES, FOR DIFFERENT KINDS OF COAL.

To the President and Members of the
American Railway Master Mechanics' Association:

Your committee, after a preliminary study of the subject, decided that it was more comprehensive and of greater scope than its limited time would allow to take up and treat thoroughly. For this reason it was decided to deal with that portion of it that concerns heating and grate surface. The remaining portion, dealing with improvements in design, is of sufficient magnitude to form an independent paper. As such a paper would be valuable, the committee recommends that it be considered as a subject for the next convention and a new committee appointed to investigate and report on it.

Knowing from past experience that it is difficult to obtain from the members full and prompt replies to a circular of inquiry, the data for this paper was obtained from the technical press. It consists of the engines illustrated by the different railroad papers during the years 1900, 1901 and the first four months of 1902. As only new types of engines, representing the most advanced ideas of buyer and builder, are so treated, it will be seen that the data is reliable, full and covers the most recent practice. In addition to the engines obtained in this manner, a few engines with boilers

and fire-boxes for burning anthracite coal, the performances of which are known by the committee, have been added.

The ratios given by the committee, in its report to the Association at the convention of 1897, do not cover the recent increase in grate surface, and the basis of comparison of the previous ratios determined for the Association contains only one factor — the working force. This factor alone, without considering speed, with which the problem is so intimately connected, is of very little real value for accurately determining the correct proportions of a boiler. If, however, we combine the working force with the speed or rate of working, we then have the power. As the boiler must furnish a certain amount of power, or an amount of energy sufficient to perform a certain amount of work in a given time, it becomes apparent at once that the real basis from which the amount of heating surface should be computed is the maximum power, and that the total heating surface of any boiler is the product of a constant, times the maximum power demanded by the service. If we take for the unit of power, a horse-power, the formula for heating surface becomes of the following form:

Total heating surface = (constant) × maximum horse-power.

The formula for horse-power is:

$$\frac{P\ L\ A\ N}{33000} \quad (1)$$

Where P = The mean effective pressure or Pm.
L = The length of stroke (feet) or S/12.
A = The area of cylinder or, $\frac{1}{4}\ \pi\ d^2$.
N = The number of strokes, or 2 × revolutions per minute for one side, or 4 (R. P. M.) as a total.

$$\text{Also R. P. M.} = \frac{\text{Miles per hour} \times 5280}{60 \times \text{circumference of drivers (feet)}}$$

Where circumference of drivers = π D/12. Substituting the above values for the factors in (1) it becomes:

$$\text{H. P.} = \frac{Pm\ \text{S}/12 \times \frac{1}{4}\ \pi\ d^2 \times 4\ (\text{M. P. H.}) \times 5280}{33000 \times 60 \times \pi\ \text{D}/12}$$

$$\text{Eliminating, H. P.} = \frac{Pm\ d^2\ \text{S} \times (\text{M. P. H.})}{375 \times D}$$

The English rule for the maximum sustained speed of an engine is:

10 × diameter of drivers (in feet) = M. P. H.

but for the sake of simplicity, if we take the maximum sustained speed as equal to as many M. P. H. as there are inches in the diameter of the drivers, we have for the sustained speed

M. P. H. $= D$, and equation (2) becomes:

$$\frac{Pm\ d^2\ S}{375}$$

Where the M. P. H. equals the diameter of drivers in inches, the revolution per minute becomes constant, or R. P. M. = 336. The Baldwin Locomotive Works, in their handbook (page 27) shows that for 336 revolutions per minute the mean effective pressure is thirty per cent of the initial pressure, and the initial pressure to be about seventy-six per cent of boiler pressure. This makes the mean effective pressure

$$Pm = .3 \times .76 \text{ (boiler pressure)}$$
$$= .228 \text{ or } 23\% \text{ (boiler pressure) } (P).$$

Substituting this value for Pm in (3) we have:

$$\text{H. P.} = \frac{.23\ P\ d^2\ S}{375} = \frac{P\ d^2\ S}{1630}$$

Where P = boiler pressure.
d^2 = (diameter of cylinder in inches)^2.
S = Stroke (in inches).

The above, while applying to simple engines, does not apply to compounds, nor is there any available data to show the average mean effective pressure of a compound at high speeds. If, however, we equate the gross tractive power of a compound engine to the gross tractive power of a similar simple engine, and then solve for cylinder diameter, we have the size of a simple cylinder having the same power as the compound. This was done for the compound engines, and the size of the equivalent simple cylinders are shown on the data sheets. It is admitted that this method is open to criticism, yet as the results are to be used for comparative purposes, in the absence of more authentic information, it provides a basis for comparison and indicates limits which may be of service in future designing. As the horse-power formula has as its basis the results of a large number of indicator cards, it might be appropriate to speak of horse-power determined in the manner as "indicated horse-power" (I. H. P.), and it will be so referred to in this report.

The important relations in boiler design are those between the power and total heating surface, between the total heating surface and grate area, and between the power and grate area. These relations for the engines in question have been determined, and some additional ratios that are of no special value, but rather as being of interest in making comparisons. The ratios have all been tabulated on the data sheets and, in some cases, the average of such ratios will also be found there. These averages, however, are not satisfactory in determining limits, and the relations have in all cases been determined graphically.

Referring to Plate I in the appendix, the maximum, mean and minimum ratios of total heating surface to maximum I. H. P. have been determined as follows: Using as ordinates the value of these two factors, a

point was determined for each engine under consideration. A line drawn approximately through the middle of these points is an average or mean location of all points. If in the equation of a straight line, $y = ax + b$, we substitute the ordinates of any point on the line, we have an equation where if one of the ordinates be known, the other can be determined. After locating the mean line, the extreme lines representing the maximum and minimum limits were drawn and their equations determined. In locating the limiting lines it has not seemed advisable where one point or engine comes some distance outside of the others, to allow it to have too great an influence in determining the location of the lines, so that the limiting lines are the limits of average practice. All ratios have been determined separately for

(*a*) Simple passenger engines.
(*b*) Compound passenger engines.
(*c*) Simple freight engines.
(*d*) Compound freight engines.

Where the ratios deal with grate areas, these divisions have been further subdivided so as to cover both anthracite and bituminous coal. The number of engines constituting the data from which the grate area proportions for anthracite coal were determined is small — in one case only three engines. Each engine, however, represents a class in which there are a large number of individual engines, and it is known that their performance is satisfactory.

RESULTS.

For the ratio $\dfrac{\text{Total heating surface}}{\text{Max. Ind. horse-power.}}$

We have:

(PLATES I, II, III, IV.)

Kind of Engines	Simple Passenger.	Compound Passenger.	Simple Freight.	Compound Freight.
Maximum ratio or square feet of heating surface per horse-power.	2.39	2.58	2.30	2.15
Mean ratio or square feet of heating surface per I. H. P.	2.00	2.13	1.71	1.80
Minimum ratio or square feet of heating surface per I. H. P.	1.72	1.70	1.48	1.58

The compound passenger engines show the greatest variation between extremes, and the compound freights the least, while the compound engines have in each service a higher mean ratio than the simple engines.

For the ratios $\dfrac{\text{Total heating surface}}{\text{Grate area}}$

We have:

(PLATES V-XII.)

Kind of Fuel.......	Bituminous Coal.				Anthracite Coal.			
Kind of Engines..	Simple Pass.	Comp'd Pass.	Simple Freight	Comp'd Freight	Simple Pass.	Comp'd Pass.	Simple Freight	Comp'd Freight
$\frac{T\ H\ S}{G\ A}$, or square feet of heating surface per square foot of grate — Maximum ratio.....	90.50	94.50	87.00	87.50	40.38	35.38	37.38	45.63
Mean ratio.........	66.67	75.00	71.50	66.67	33.50	32.75	31.63	39.25
Minimum ratio	51.50	62.91	47.00	51.25	27.75	23.63	27.88	30.63

In the above table, under bituminous coal, the ratios found cover grate areas for burning nearly all grades of this coal. The maximum ratio is probably only suitable for extremely free burning qualities, and should not be exceeded. The mean ratio is probably suitable for the average quality of bituminous fuel, while the minimum limit is suitable for the poorer qualities. While division is made between anthracite and bituminous coal on the diagrams and tables, in reality no such division exists, the maximum ratios under the latter head being suitable for slack bituminous coal, and in fact one lot of engines plotted under this head burns bituminous coal. The higher ratios under anthracite coal are really only suitable for low grades of bituminous coals or a mixture of ordinary bituminous coal with fine anthracite. The mean ratios are suitable for good lump anthracite, and mixtures of bituminous and fine anthracite, while the minimum ratios are none too small for ordinary lump anthracite, mixture of fine anthracite and bituminous, and fine anthracite alone. It is not possible to define absolutely the necessary amounts of grate surface for the varying qualities of fuel that are in use, but the ratios show limiting practices and to a certain extent should be useful, as indicating for average bituminous and anthracite coal the proportions used in most recent constructions.

Plates XIII-XVI give the ratios between the tube heating surface and the fire-box heating surface. This ratio is of no particular value, as the grate area controls it to a large extent, but may prove of interest, as the graphical analysis shows the relation between them to follow a fairly defined law.

The ratios as derived are:

Kind of Engine	Simple Passenger.	Compound Passenger.	Simple Freight.	Compound Freight.
Maximum ratio or square feet of tube heating surface per square foot of fire-box heating surface.	16.67	18.56	18.50	17.56
Mean ratio or square feet of tube heating surface per square foot of fire-box heating surface......	13.42	13.42	12.75	13.58
Minimum ratio or square feet of tube heating surface per square foot of fire-box heating surface.	10.25	10.09	9.04	11.50

Plates XVII-XX show the relation between power and weight, and are to a certain extent an index to the probable weight of a new engine after the power has been decided.

These ratios are:

Kind of Engine	Simple Passenger.	Compound Passenger.	Simple Freight.	Compound Freight.
Maximum ratio or weight in lbs. per I. H. P....................	145.0	165.0	142.5	127.50
Mean ratio or weight in lbs. per I. H. P........................	127.0	135.0	115.5	113.25
Minimum ratio or weight in lbs. per I. H. P....	108.0	111.0	101.25	102.25

A table of all ratios derived will be found in the appendix, as well as the interpretation of the grate area in relation to the fuel as outlined heretofore.

The committee, in connection with this report, recommends that the Association adopt as a standard:

(1) For comparisons of heating surface, the relation between the indicated horse-power and total heating surface, the formula for I. H. P. being:

$$\text{I. H. P.} = \frac{P\,d^2\,S}{1630}$$

Where P = Boiler pressure.
d^2 = (Diameter of cylinder in inches)^2.
S = Stroke in inches.

(2) For comparisons of weight, the relation between the indicated horse-power and the total weight of engine.

In case of the adoption of these methods by the Association it is further recommended that the Secretary of the Association be instructed to communicate with the technical press and request their coöperation in the use of these methods of comparison.

GEO. W. WEST, Chairman,
T. W. DEMAREST,
H. D. TAYLOR,
JOHN PLAYER,
Committee.

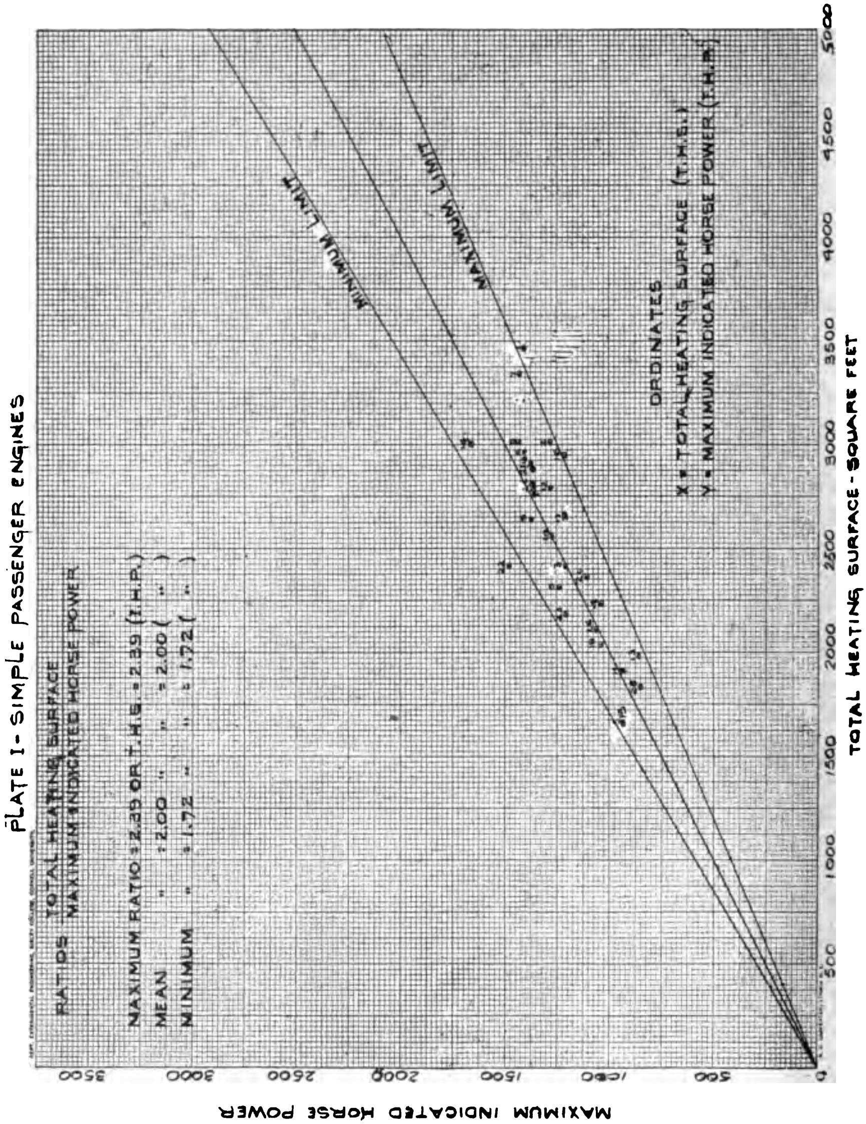


PLATE I - SIMPLE PASSENGER ENGINES
RATIOS TOTAL HEATING SURFACE / MAXIMUM INDICATED HORSE POWER
MAXIMUM RATIO = 2.39 OR T.H.S. = 2.39 (I.H.P.)
MEAN " = 2.00 " " = 2.00 (")
MINIMUM " = 1.72 " " = 1.72 (")
MINIMUM LIMIT
MAXIMUM LIMIT
ORDINATES
X = TOTAL HEATING SURFACE (T.H.S.)
Y = MAXIMUM INDICATED HORSE POWER (I.H.P.)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
TOTAL HEATING SURFACE - SQUARE FEET
MAXIMUM INDICATED HORSE POWER

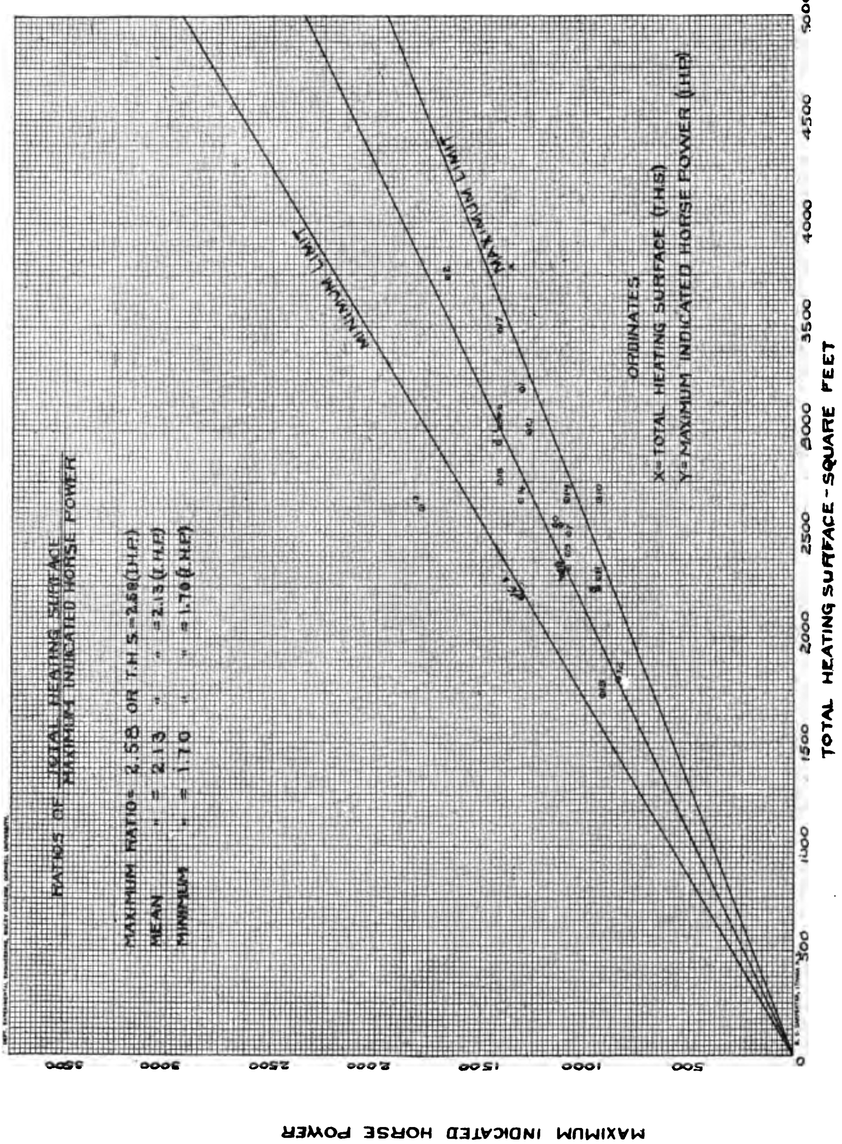


PLATE II-COMPOUND PASSENGER ENGINES

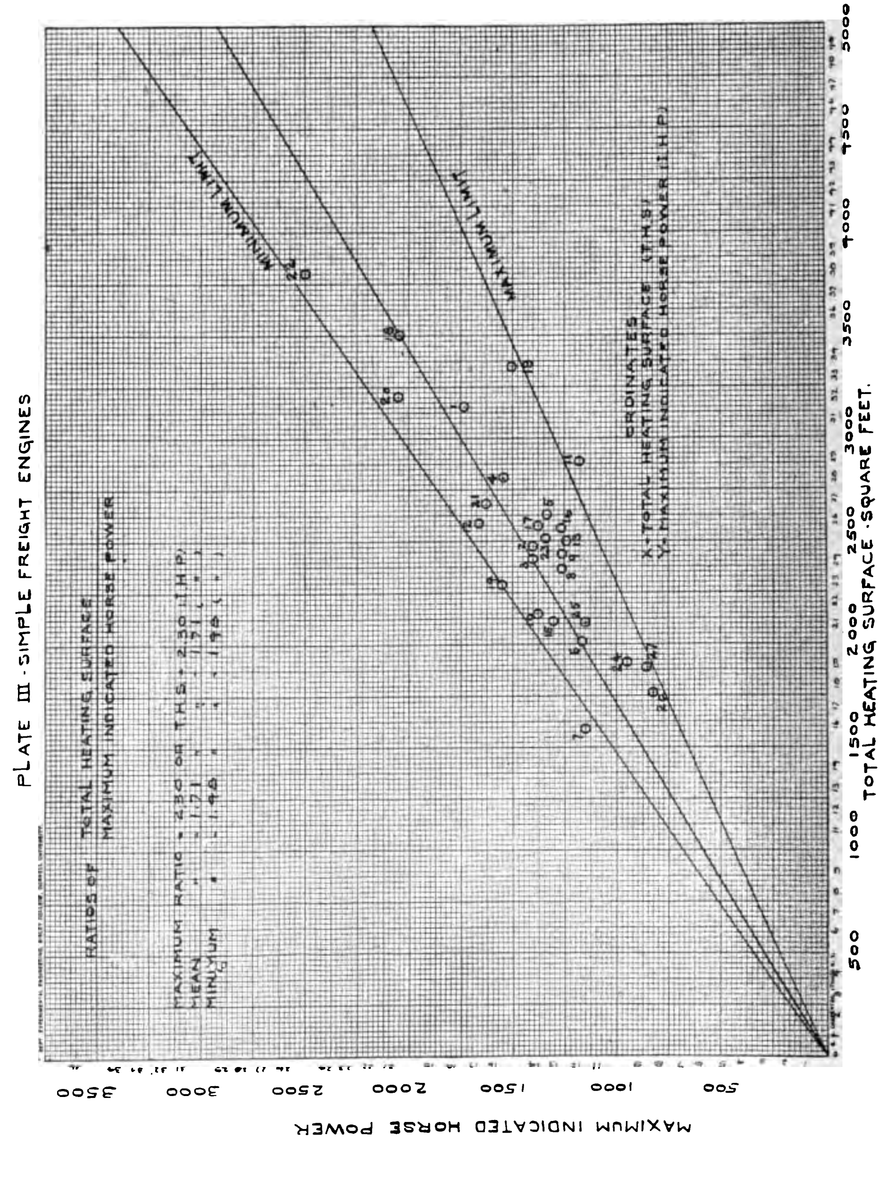


PLATE III · SIMPLE FREIGHT ENGINES
RATIOS OF TOTAL HEATING SURFACE / MAXIMUM INDICATED HORSE POWER
MAXIMUM RATIO = 2.30 OR T.H.S. = 2.30 (I.H.P.)
MEAN " = 1.71 " " = 1.71 (")
MINIMUM " = 1.46 " " = 1.46 (")
MINIMUM LIMIT
MAXIMUM LIMIT
ORDINATES
X = TOTAL HEATING SURFACE (T.H.S.)
Y = MAXIMUM INDICATED HORSE POWER (I.H.P.)
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
TOTAL HEATING SURFACE · SQUARE FEET.
500
1000
1500
2000
2500
3000
3500
MAXIMUM INDICATED HORSE POWER

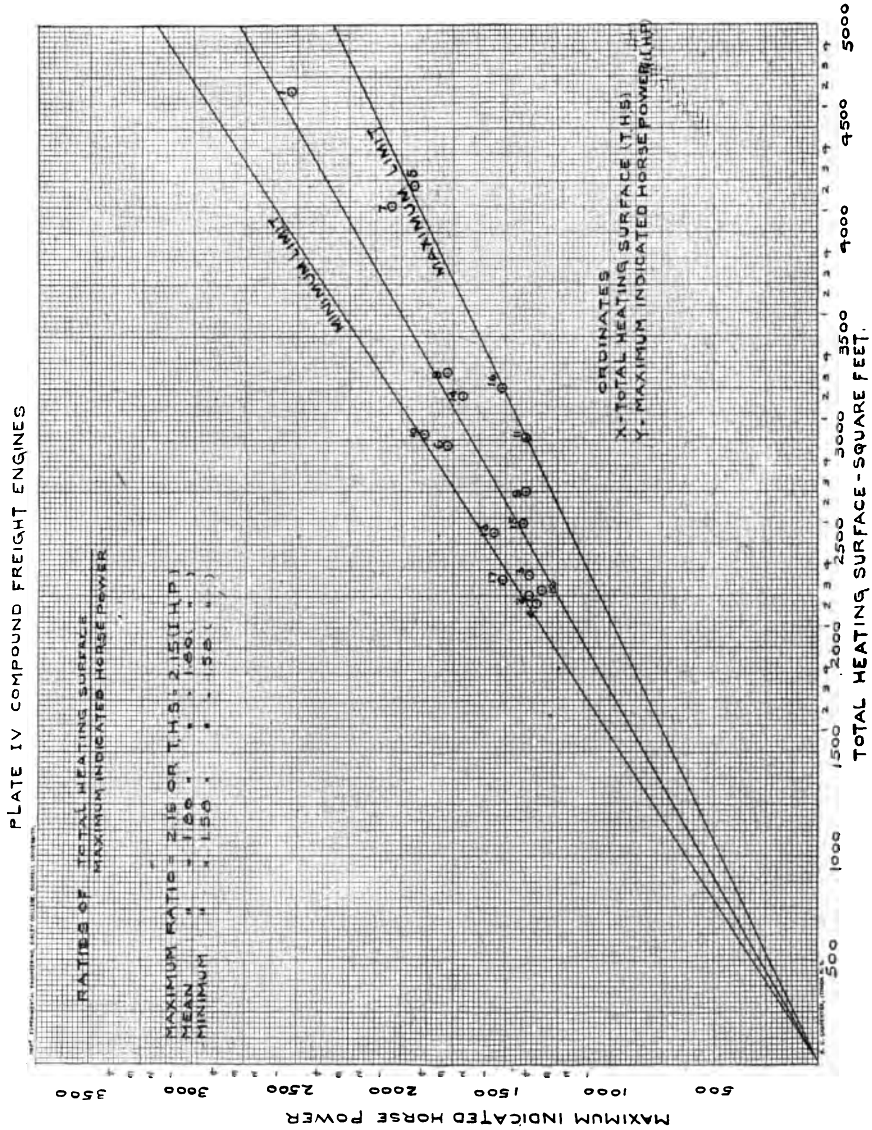


PLATE IV COMPOUND FREIGHT ENGINES
RATIOS OF TOTAL HEATING SURFACE / MAXIMUM INDICATED HORSE POWER
MAXIMUM RATIO = 2.16 OR T.H.S. = 2.15 (I.H.P.)
MEAN " = 1.80 " " = 1.80 (")
MINIMUM " = 1.58 " " = 1.58 (")
MINIMUM LIMIT
MAXIMUM LIMIT
ORDINATES
X - TOTAL HEATING SURFACE (T.H.S.)
Y - MAXIMUM INDICATED HORSE POWER (I.H.P.)
TOTAL HEATING SURFACE - SQUARE FEET.
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
MAXIMUM INDICATED HORSE POWER
500
1000
1500
2000
2500
3000
3500

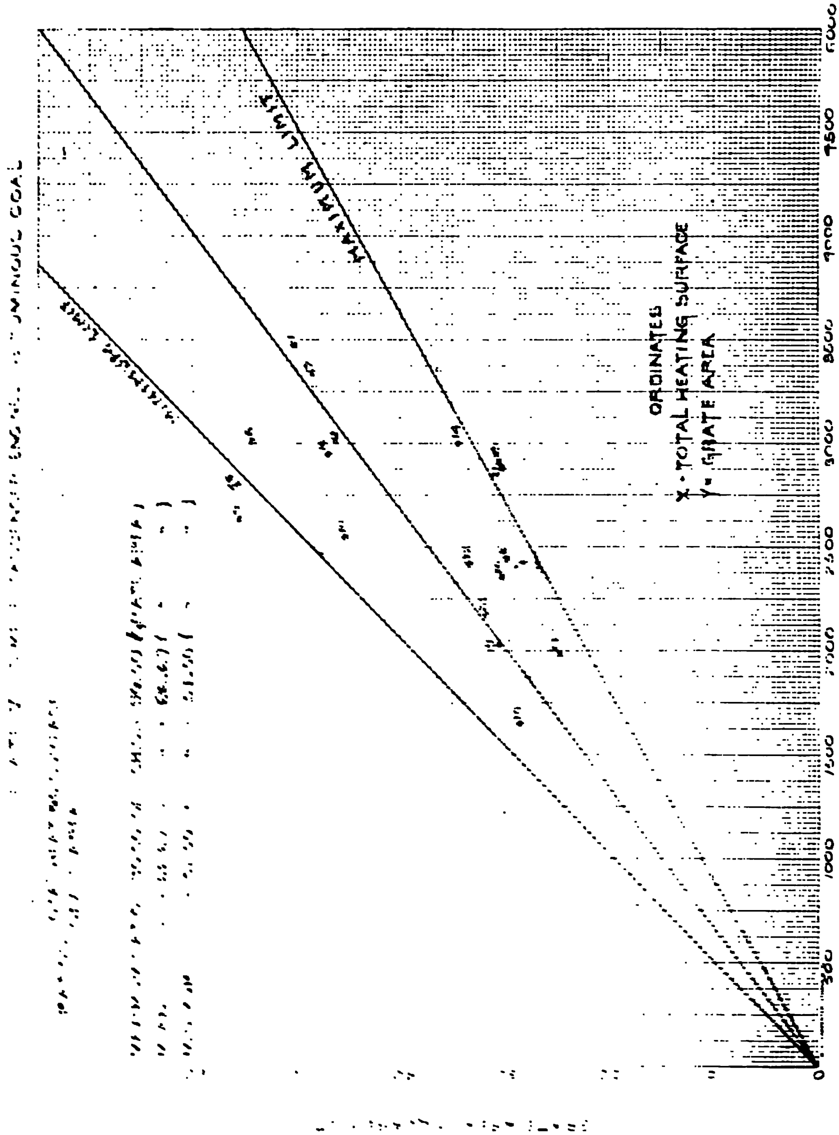
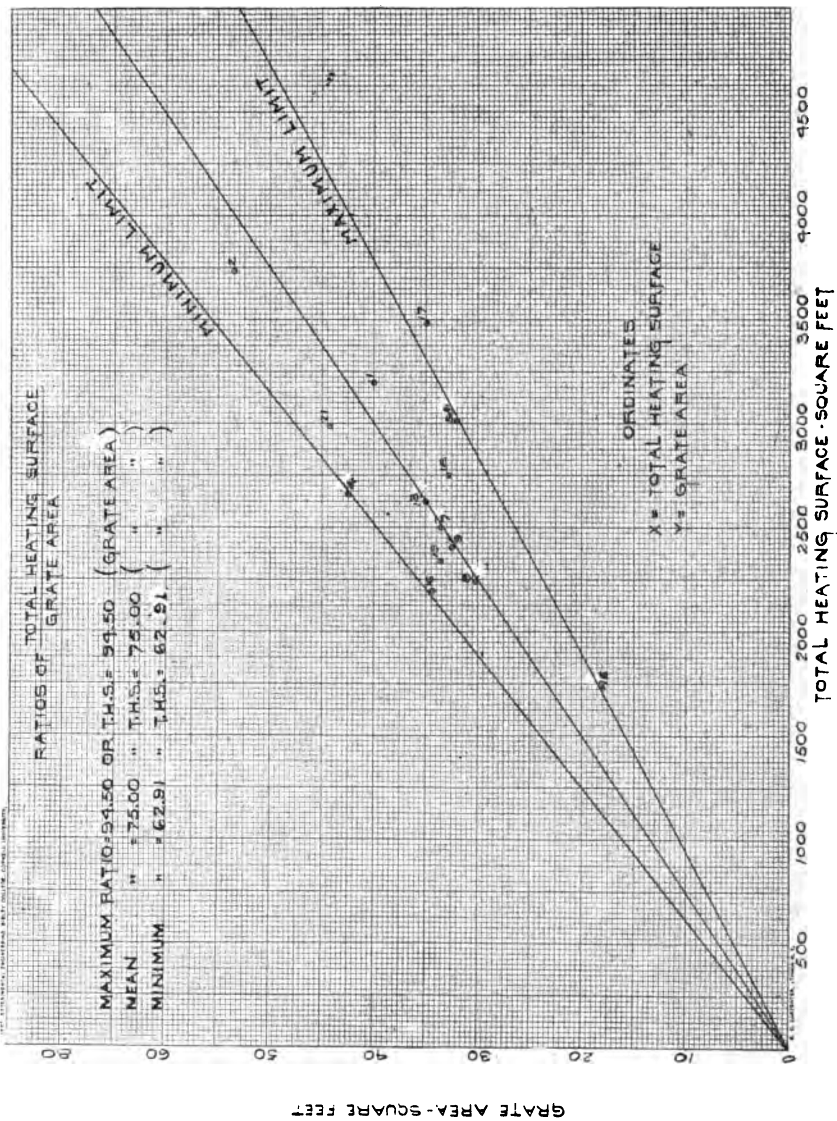

MAXIMUM LIMIT
MINIMUM LIMIT
ORDINATES
X = TOTAL HEATING SURFACE
Y = GRATE AREA
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
TOTAL HEATING SURFACE - SQUARE FEET

PLATE VI - COMPOUND PASSENGER ENGINES - BITUMINOUS COAL



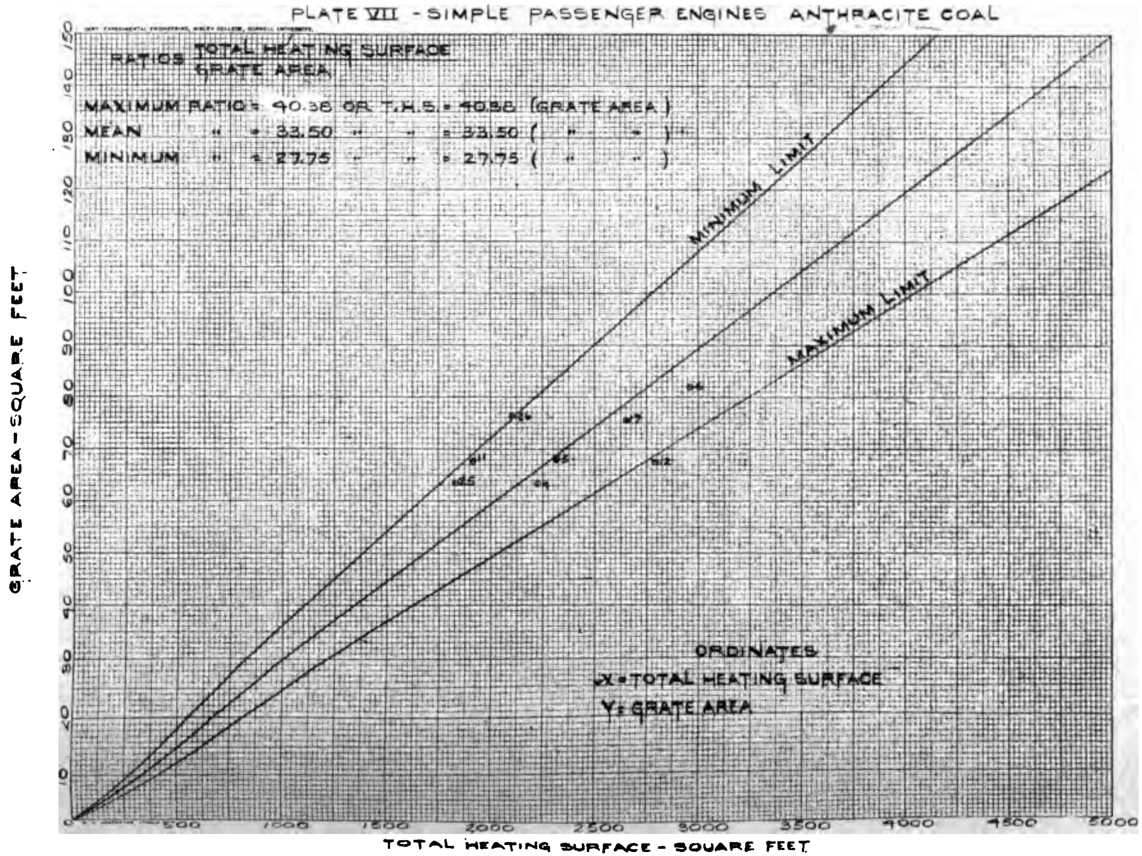


PLATE VII - SIMPLE PASSENGER ENGINES ANTHRACITE COAL
RATIOS TOTAL HEATING SURFACE / GRATE AREA
MAXIMUM RATIO = 40.36 OR T.H.S. = 40.36 (GRATE AREA)
MEAN " = 33.50 " " = 33.50 (" ")
MINIMUM " = 27.75 " " = 27.75 (" ")
MINIMUM LIMIT
MAXIMUM LIMIT
ORDINATES
X = TOTAL HEATING SURFACE
Y = GRATE AREA
TOTAL HEATING SURFACE - SQUARE FEET
GRATE AREA - SQUARE FEET

PLATE VIII · COMPOUND PASSENGER ENGINES-ANTHRACITE COAL

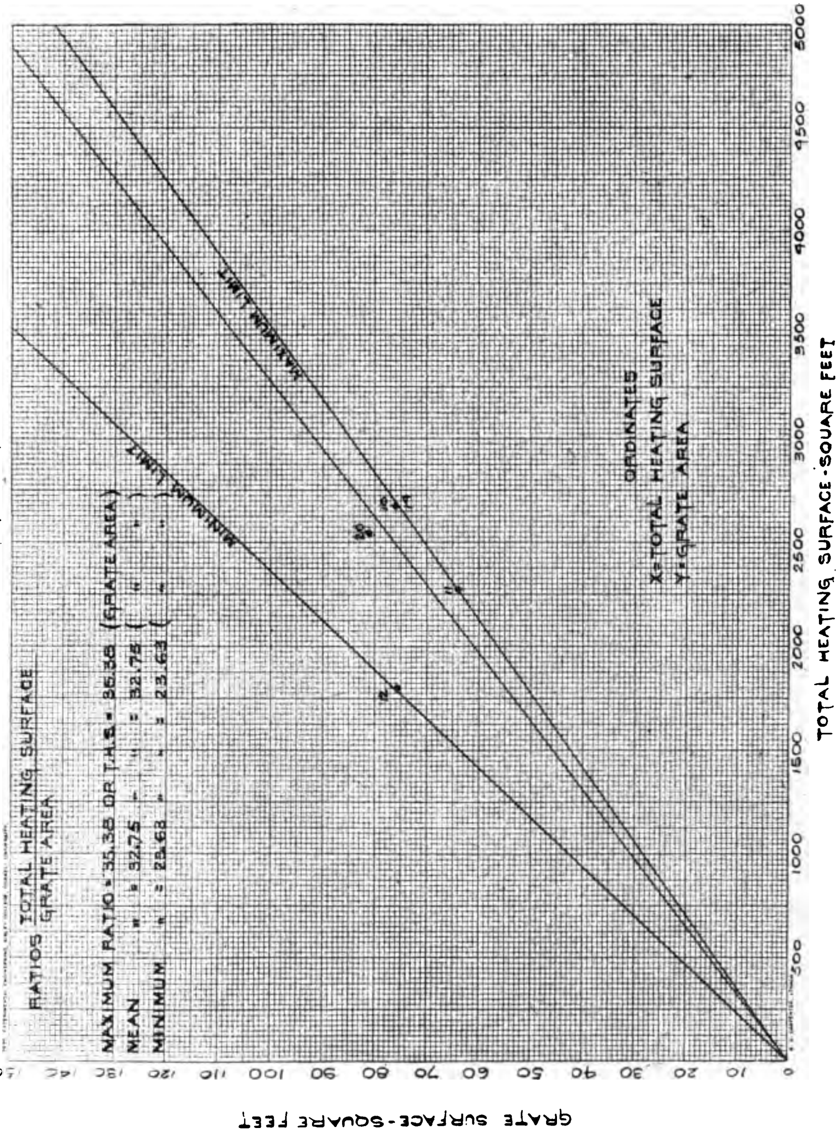
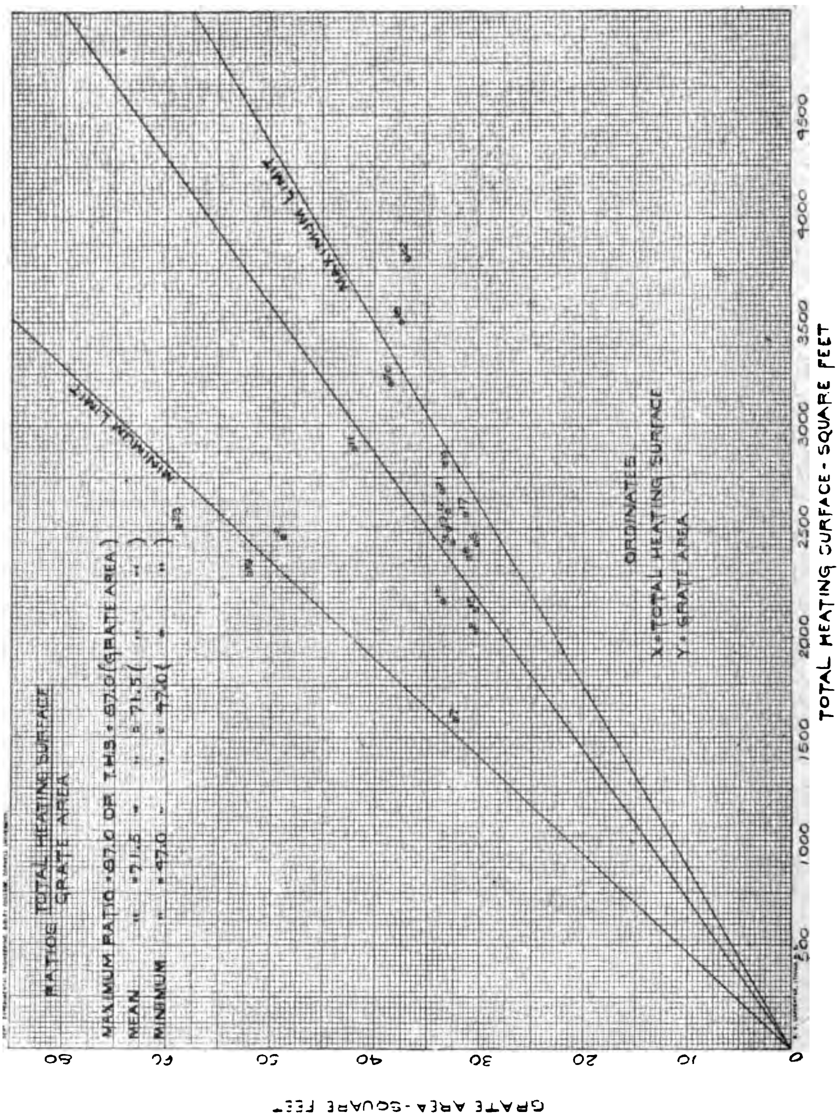


PLATE IX - SIMPLE FRIEGHT ENGINES - BITUMINOUS COAL



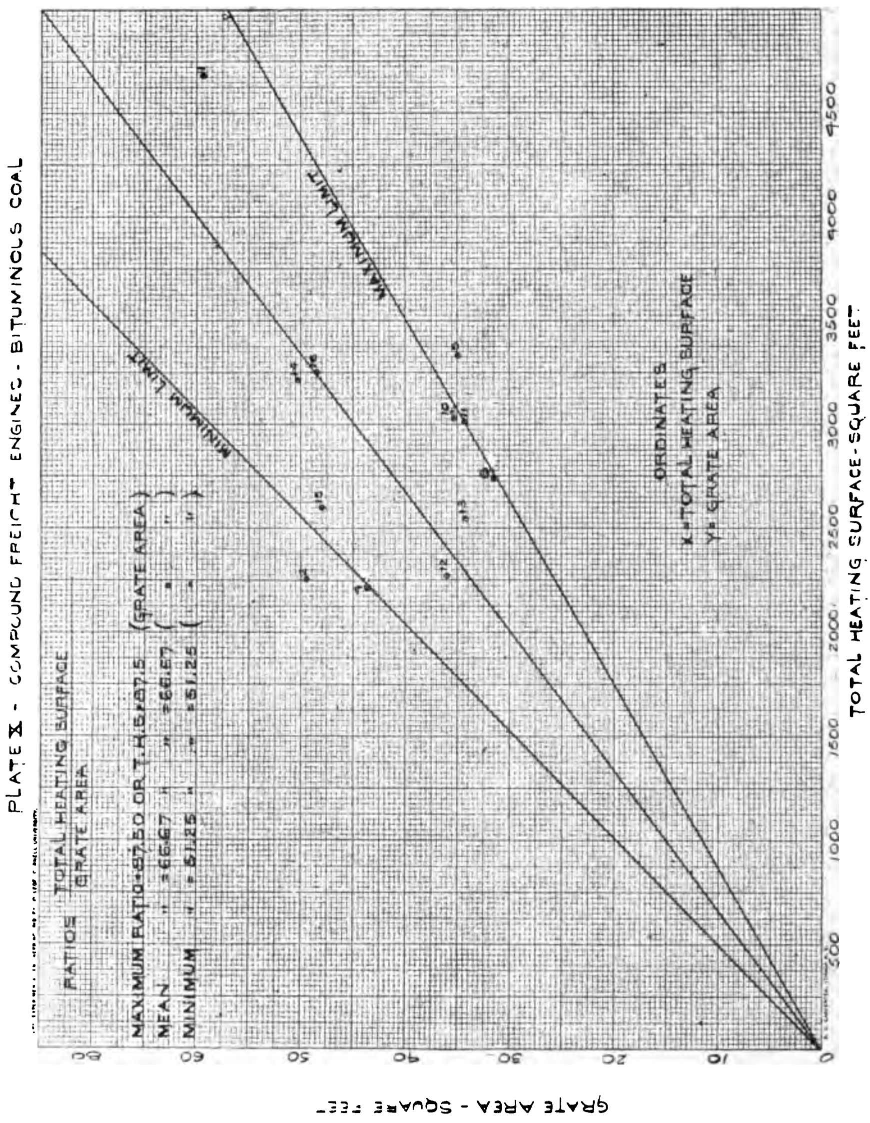


PLATE X - COMPOUND FREIGHT ENGINES - BITUMINOUS COAL
RATIOS TOTAL HEATING SURFACE / GRATE AREA
MAXIMUM RATIO = 87.50 OR T.H.S. = 87.5 (GRATE AREA)
MEAN = 66.67 (GRATE AREA)
MINIMUM = 51.25 (GRATE AREA)
MAXIMUM LIMIT
MINIMUM LIMIT
ORDINATES
X = TOTAL HEATING SURFACE
Y = GRATE AREA
500 1000 1500 2000 2500 3000 3500 4000 4500
TOTAL HEATING SURFACE - SQUARE FEET
0 10 20 30 40 50 60 70 80
GRATE AREA - SQUARE FEET

PLATE XI - SIMPLE FREIGHT ENGINES - ANTHRACITE COAL

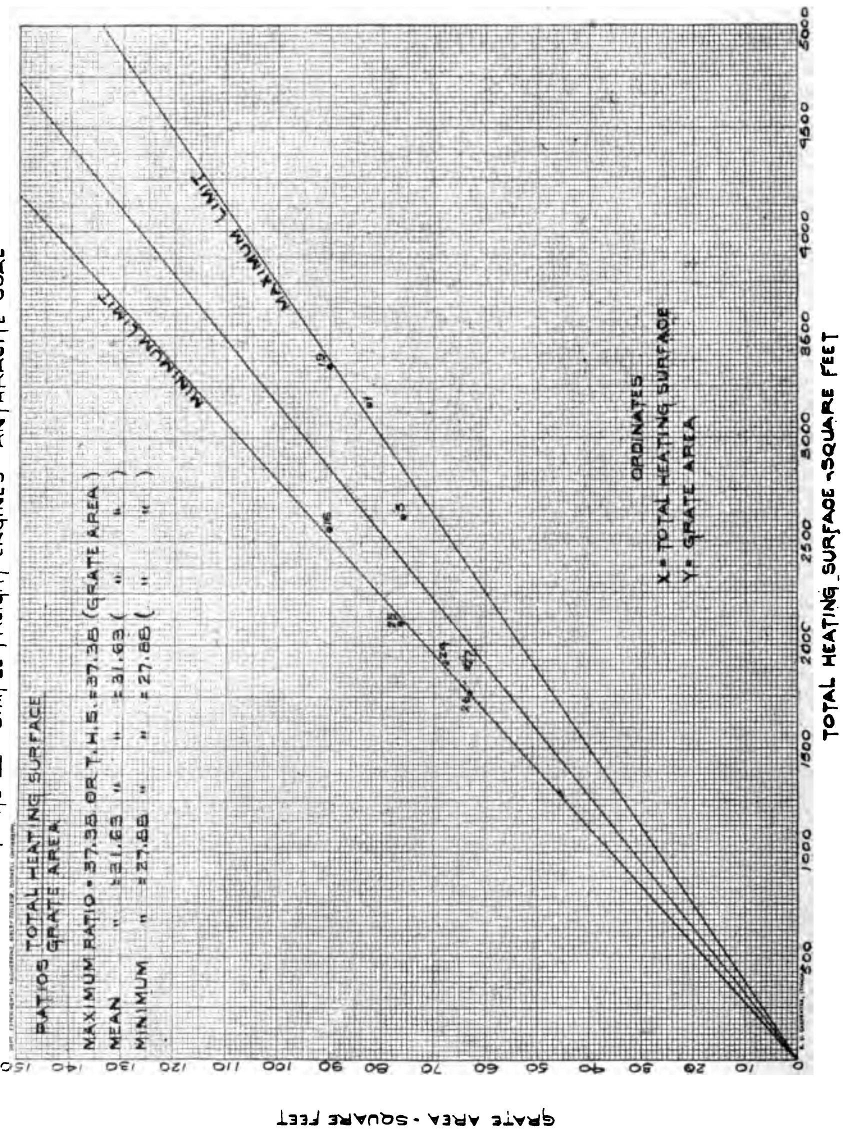
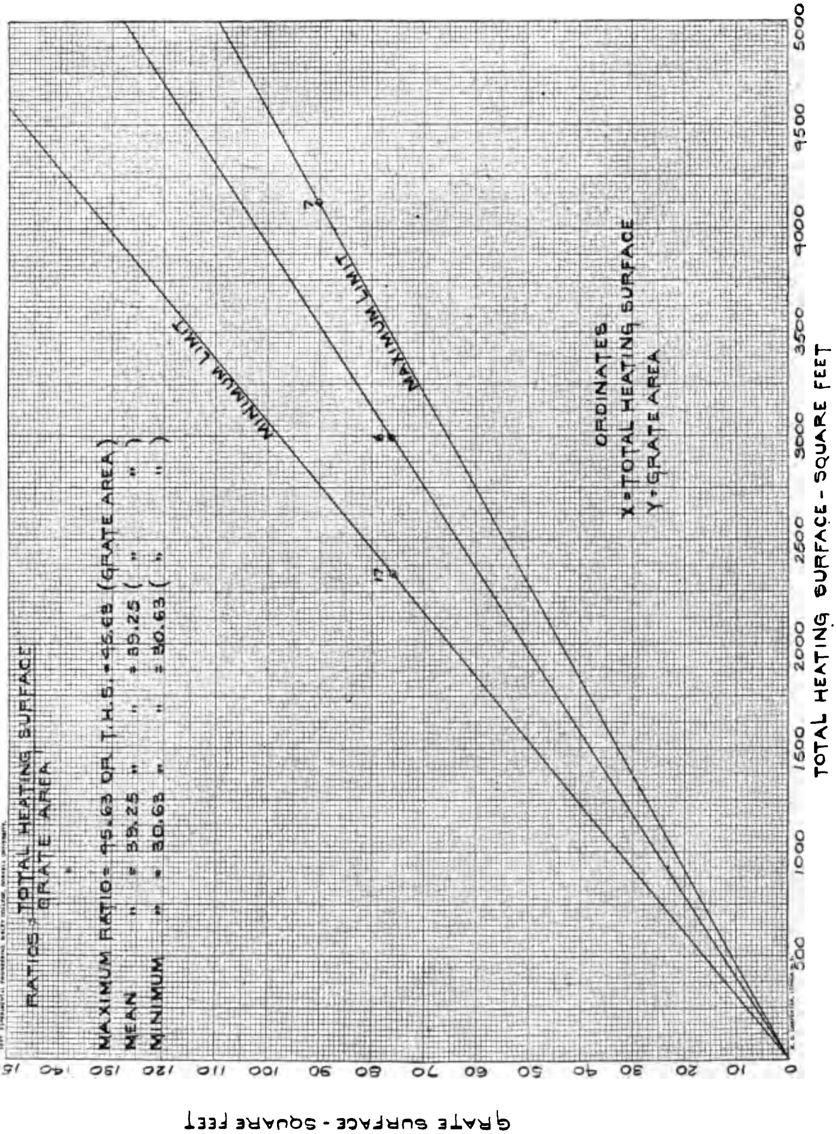
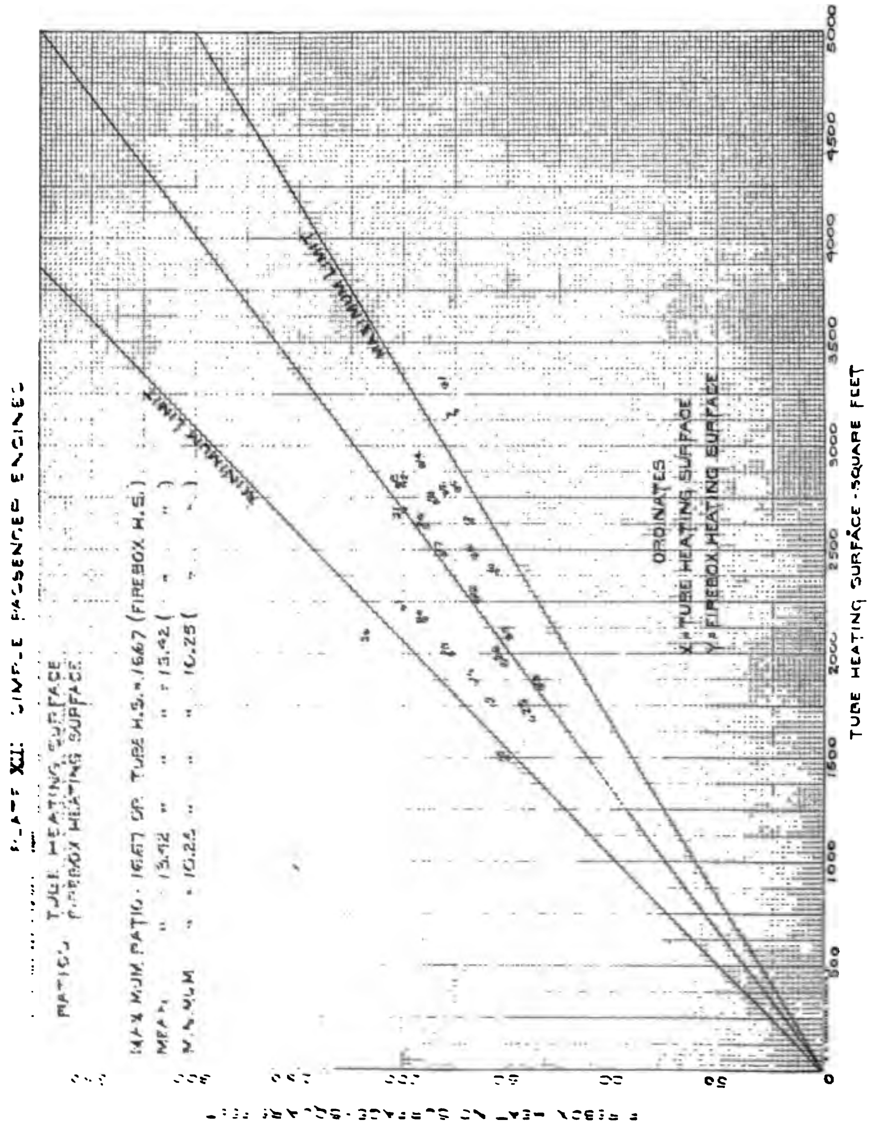


PLATE XII - COMPOUND FREIGHT ENGINES - ANTHRACITE COAL




TUBE HEATING SURFACE
FIREBOX HEATING SURFACE
MAXIMUM RATIO - 16.67 OR TUBE H.S. = 16.67 (FIREBOX H.S.)
MEAN " 13.42 " " = 13.42 (" ")
MINIMUM " 10.25 " " = 10.25 (" ")
MAXIMUM LIMIT
MINIMUM LIMIT
ORDINATES
X = TUBE HEATING SURFACE
Y = FIREBOX HEATING SURFACE
TUBE HEATING SURFACE - SQUARE FEET
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
50
0

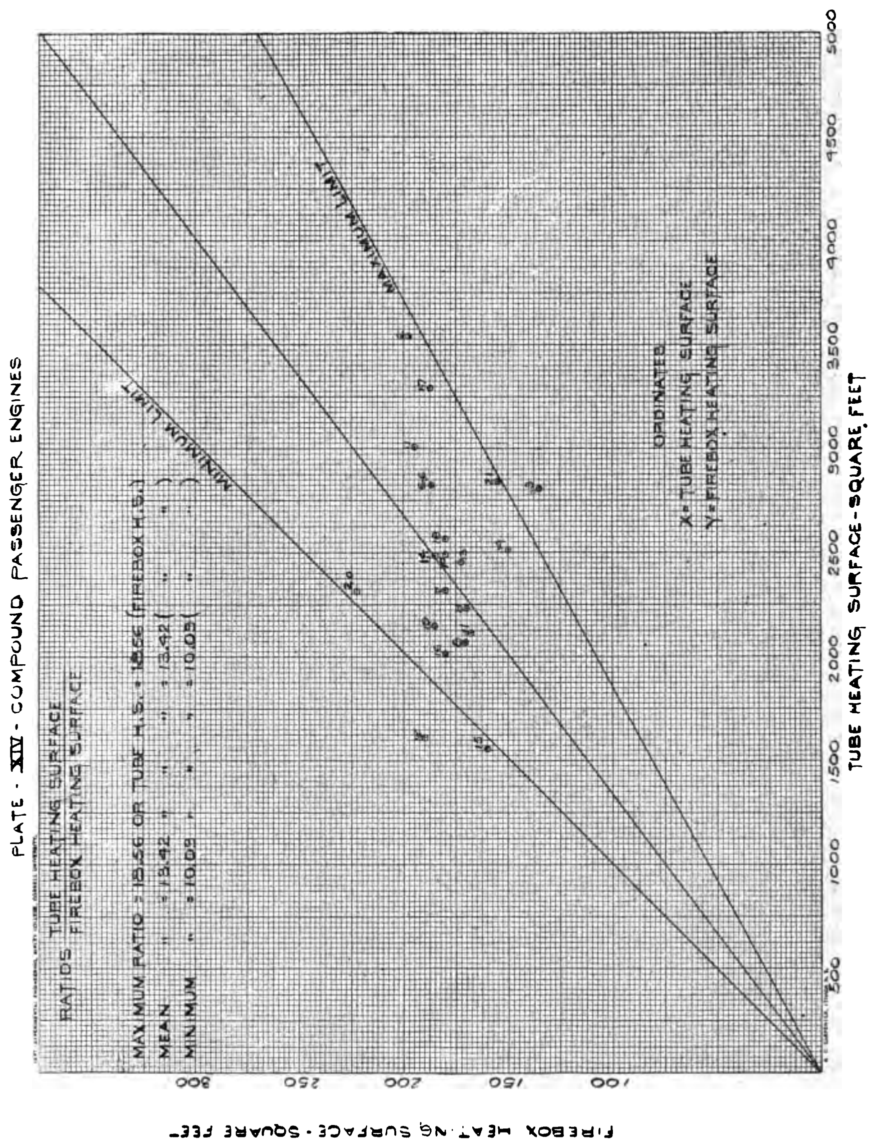


PLATE - XIV - COMPOUND P A SSENGER ENGINES
RATIOS TUBE HEATING SURFACE / FIREBOX HEATING SURFACE
MINIMUM LIMIT
MAXIMUM LIMIT
ORDINATES
X = TUBE HEATING SURFACE
Y = FIREBOX HEATING SURFACE
TUBE HEATING SURFACE - SQUARE FEET
FIREBOX HEATING SURFACE - SQUARE FEET

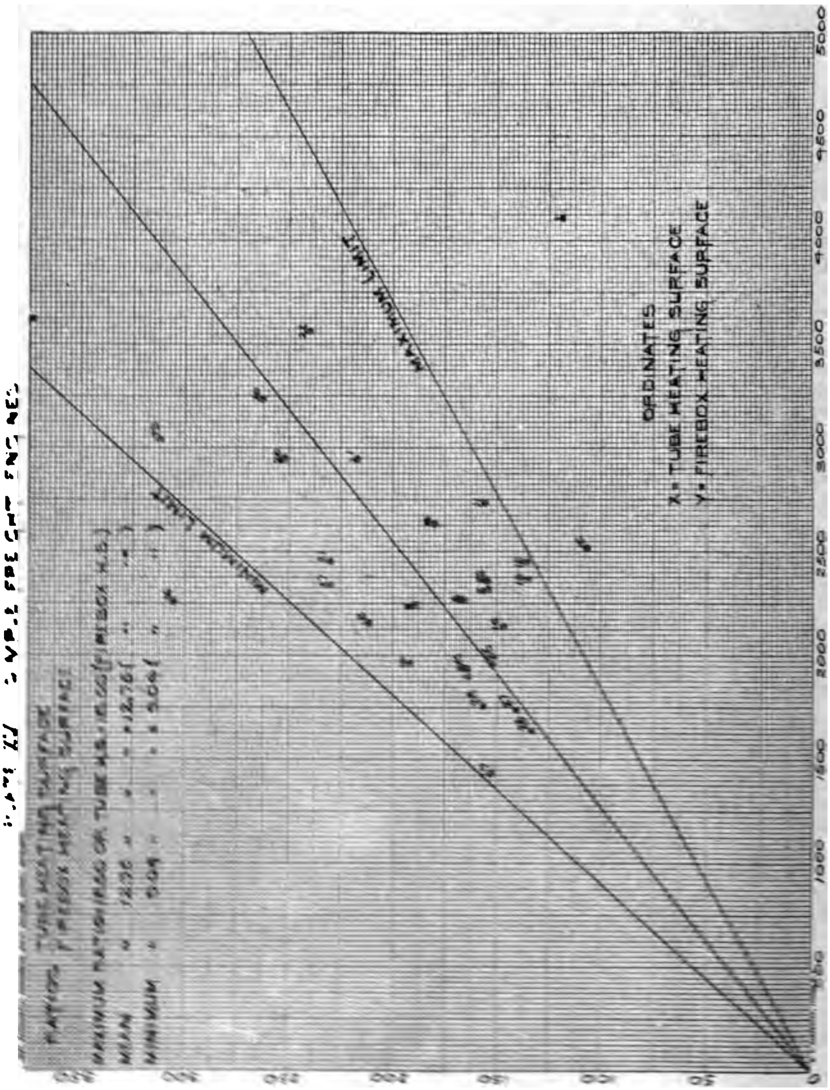
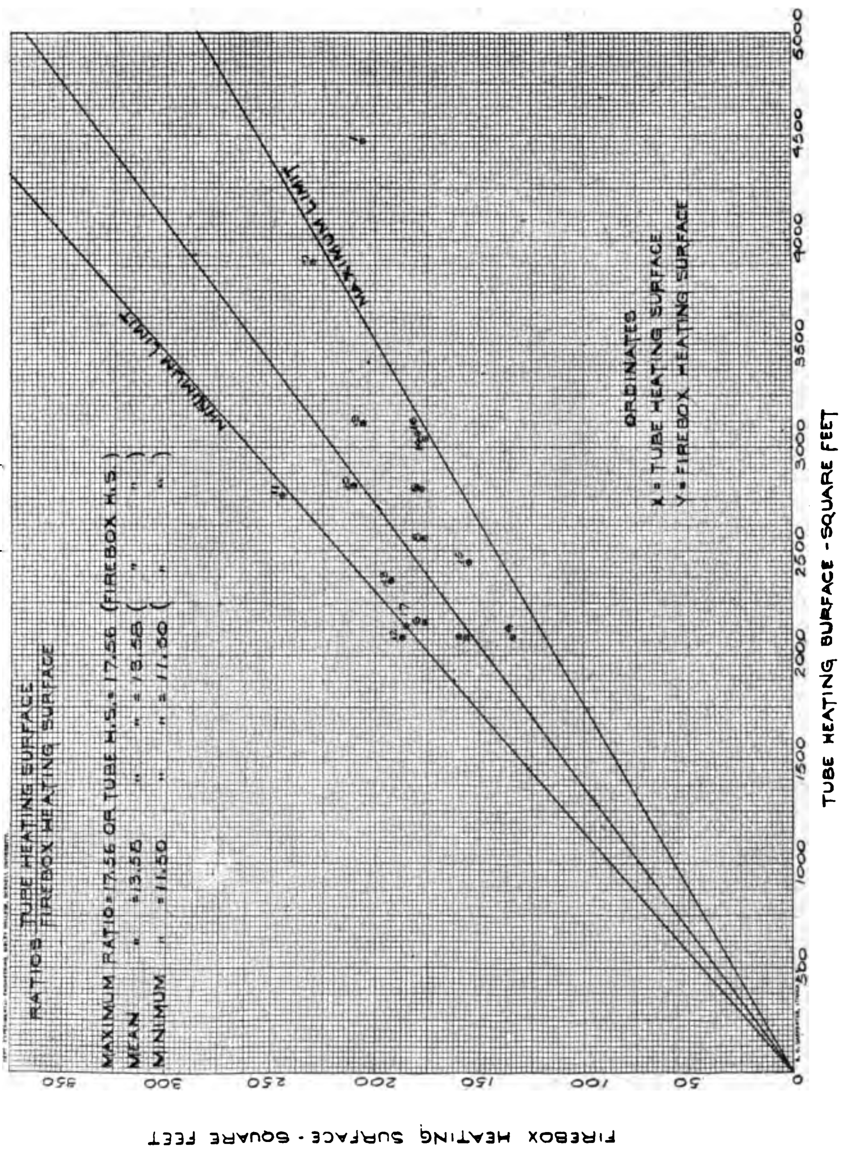

MAXIMUM LIMIT
MINIMUM LIMIT
ORDINATES
X = TUBE HEATING SURFACE
Y = FIREBOX HEATING SURFACE
TUBE HEATING SURFACE · SQUARE FEET
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000

PLATE XVI - COMPOUND FREIGHT ENGINES



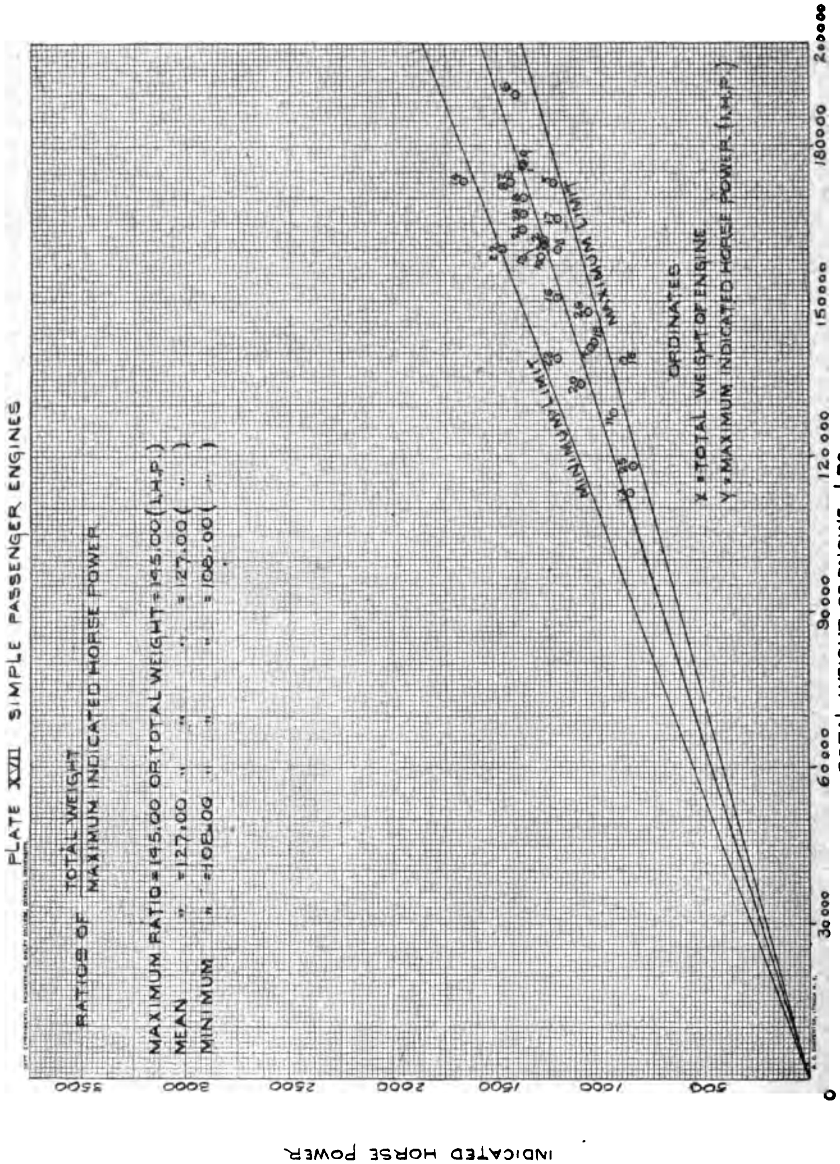


PLATE XVII SIMPLE PASSENGER ENGINES
RATIOS OF TOTAL WEIGHT / MAXIMUM INDICATED HORSE POWER
MAXIMUM RATIO = 145.00 OR TOTAL WEIGHT = 145.00 (I.H.P.)
MEAN " = 127.00 " " " = 127.00 (")
MINIMUM " = 108.00 " " " = 108.00 (")
MINIMUM LIMIT
MAXIMUM LIMIT
ORDINATES
X = TOTAL WEIGHT OF ENGINE
Y = MAXIMUM INDICATED HORSE POWER (I.H.P.)
0
30000
60000
90000
120000
150000
180000
200000
TOTAL WEIGHT OF ENGINE - LBS.
500
1000
1500
2000
2500
3000
3500
INDICATED HORSE POWER

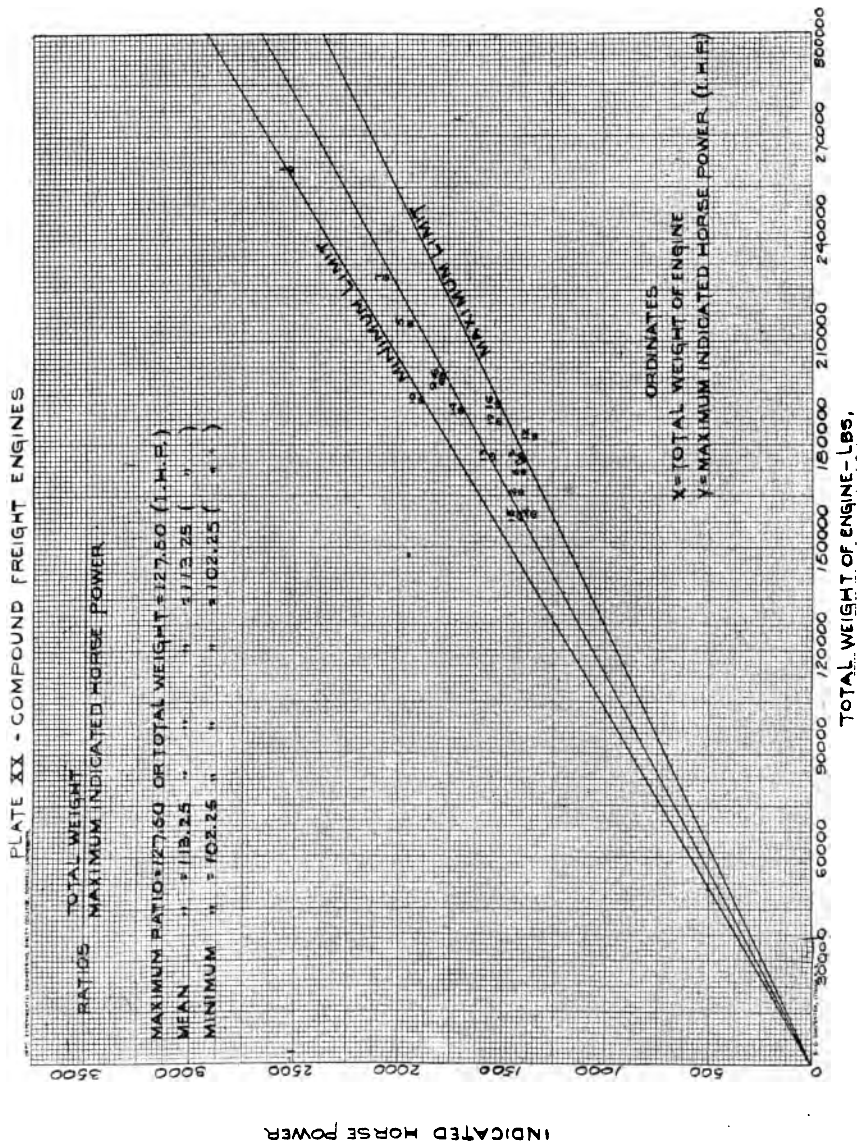


PLATE XX - COMPOUND FREIGHT ENGINES
RATIOS TOTAL WEIGHT / MAXIMUM INDICATED HORSE POWER
MAXIMUM RATIO = 127.50 OR TOTAL WEIGHT = 127.50 (I.H.P.)
MEAN " = 113.25 " " " " = 113.25 (")
MINIMUM " = 102.25 " " " " = 102.25 (")
MAXIMUM LIMIT
MINIMUM LIMIT
ORDINATES
X = TOTAL WEIGHT OF ENGINE
Y = MAXIMUM INDICATED HORSE POWER (I.H.P.)
TOTAL WEIGHT OF ENGINE - LBS.
INDICATED HORSE POWER
0
30000
60000
90000
120000
150000
180000
210000
240000
270000
300000
500
1000
1500
2000
2500
3000
3500

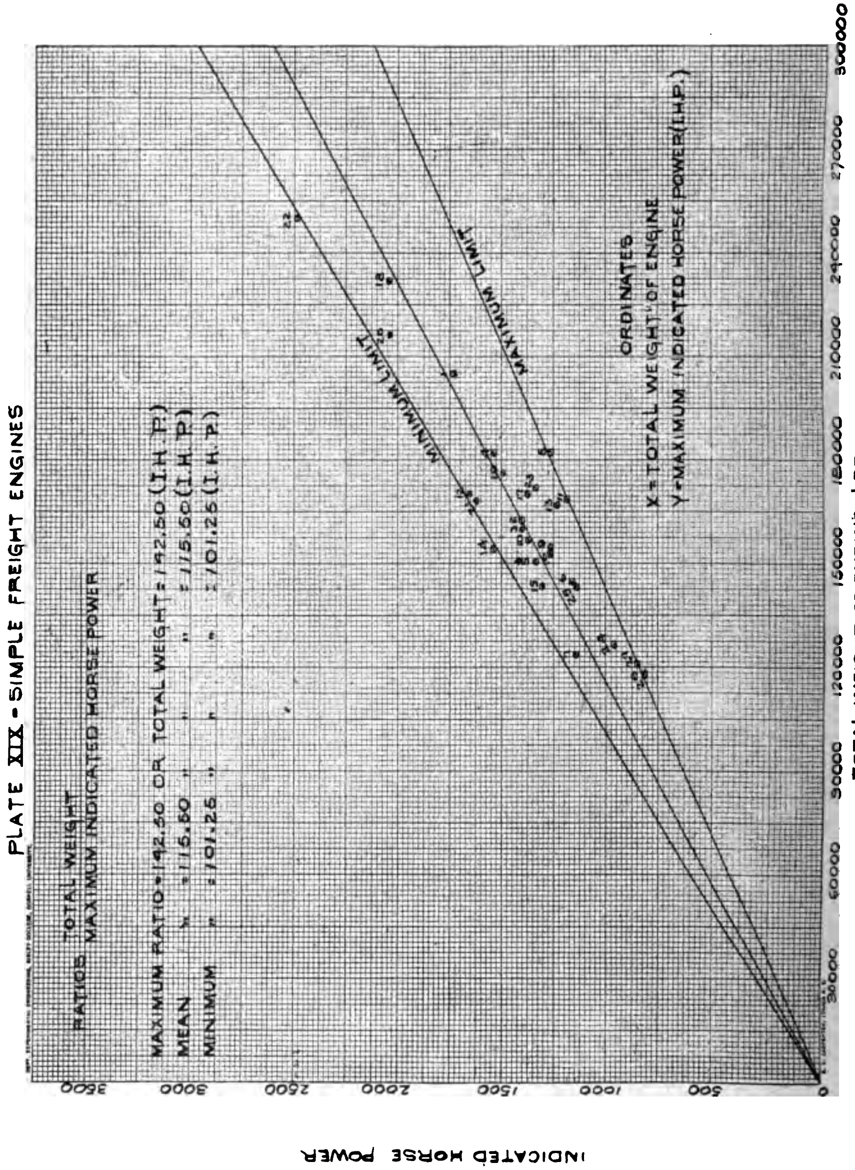


PLATE XIX - SIMPLE FREIGHT ENGINES
RATIOS TOTAL WEIGHT / MAXIMUM INDICATED HORSE POWER
MAXIMUM RATIO = 142.50 OR TOTAL WEIGHT = 142.50 (I.H.P.)
MEAN " = 115.50 " " = 115.50 (I.H.P.)
MINIMUM " = 101.25 " " = 101.25 (I.H.P.)
MINIMUM LIMIT
MAXIMUM LIMIT
ORDINATES
X = TOTAL WEIGHT OF ENGINE
Y = MAXIMUM INDICATED HORSE POWER (I.H.P.)
0
30000
60000
90000
120000
150000
180000
210000
240000
270000
300000
TOTAL WEIGHT OF ENGINE - LBS.
500
1000
1500
2000
2500
3000
3500
INDICATED HORSE POWER

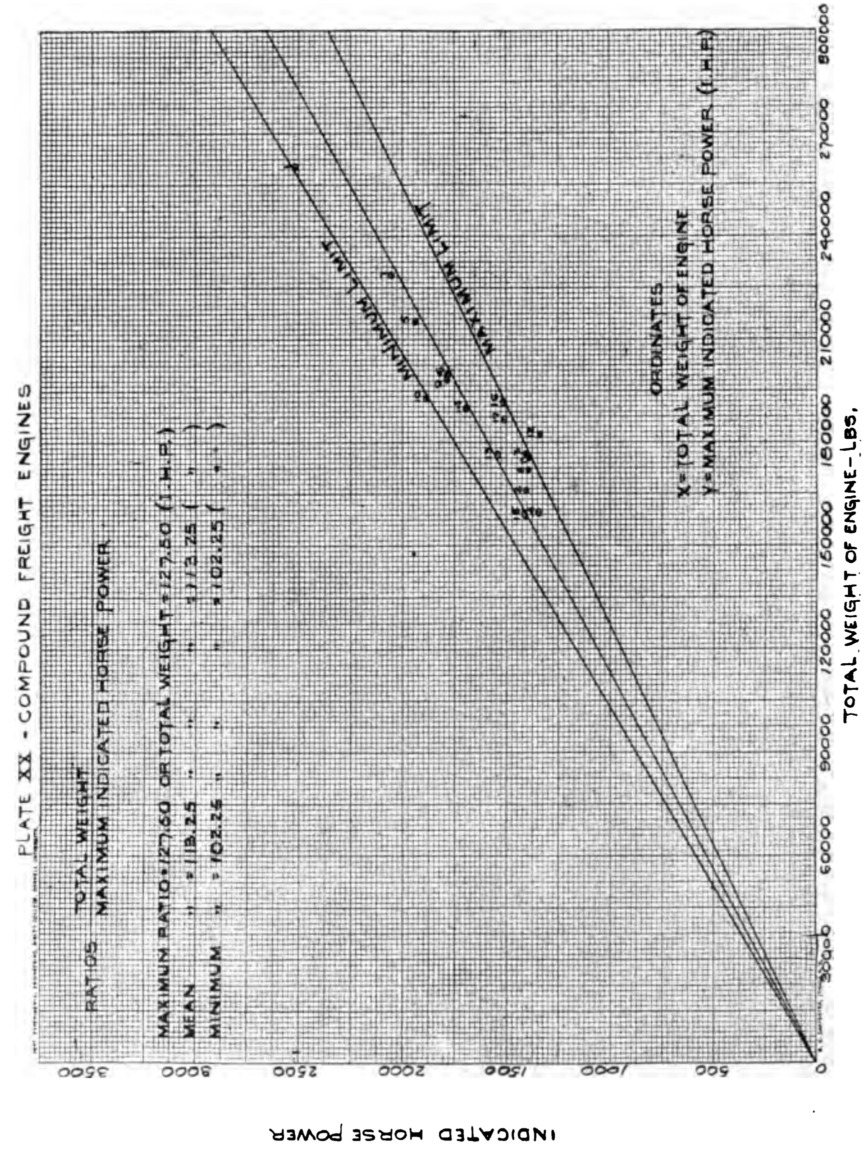
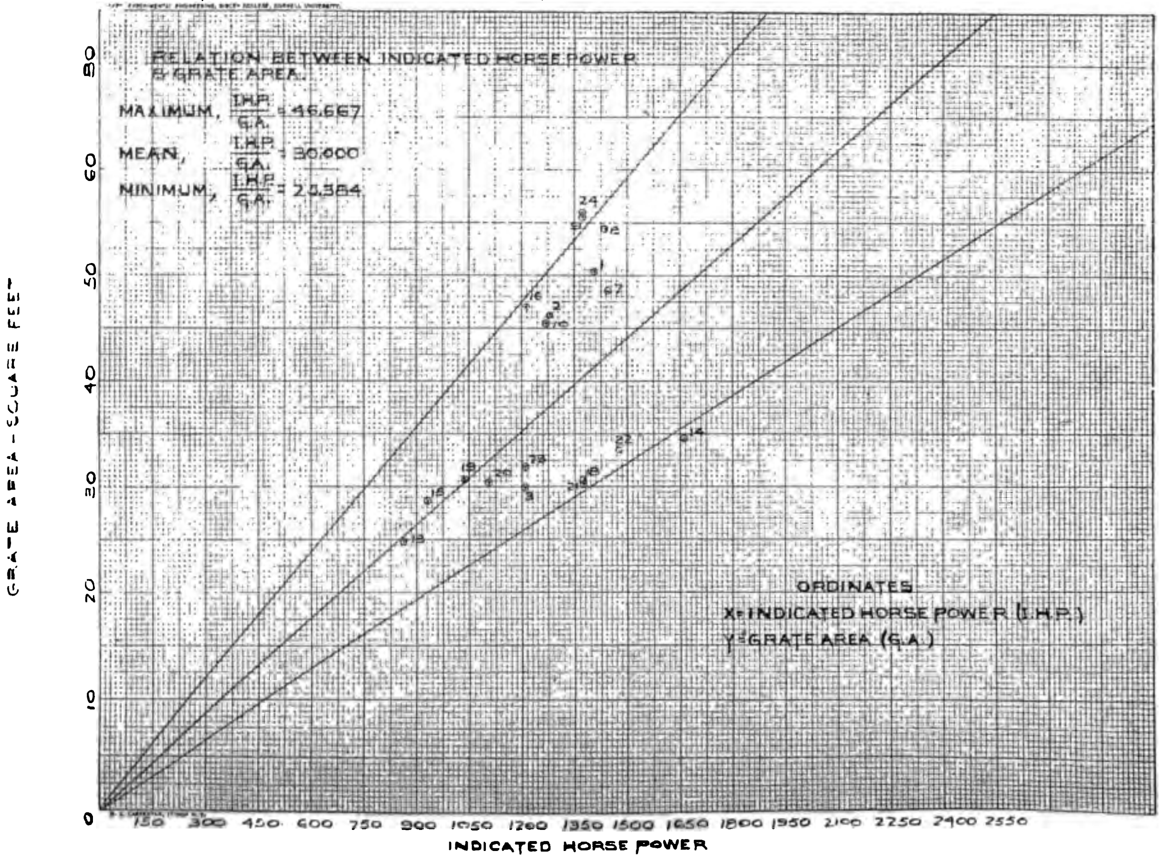


PLATE XX - COMPOUND FREIGHT ENGINES
RATIOS
TOTAL WEIGHT
MAXIMUM INDICATED HORSE POWER
MAXIMUM RATIO = 127.50 OR TOTAL WEIGHT = 127.50 (I.H.P.)
MEAN " = 118.25 " " " = 113.25 (")
MINIMUM " = 102.25 " " " = 102.25 (")
MINIMUM LIMIT
MAXIMUM LIMIT
ORDINATES
X = TOTAL WEIGHT OF ENGINE
Y = MAXIMUM INDICATED HORSE POWER (I.H.P.)
TOTAL WEIGHT OF ENGINE - LBS.
INDICATED HORSE POWER
0
500
1000
1500
2000
2500
3000
3500
30000
60000
90000
120000
150000
180000
210000
240000
270000
300000

PLATE XXI — SIMPLE PASSENGERS ENGINES - BITUMINOUS COAL



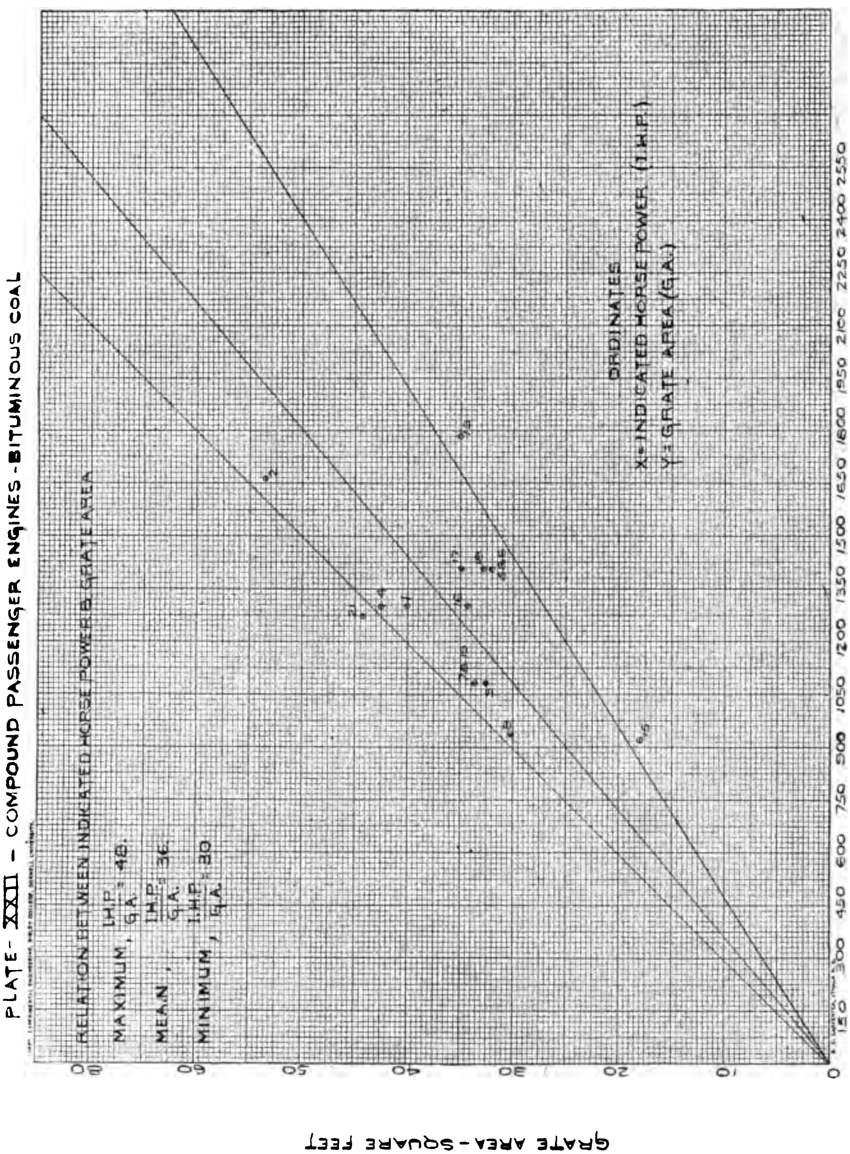
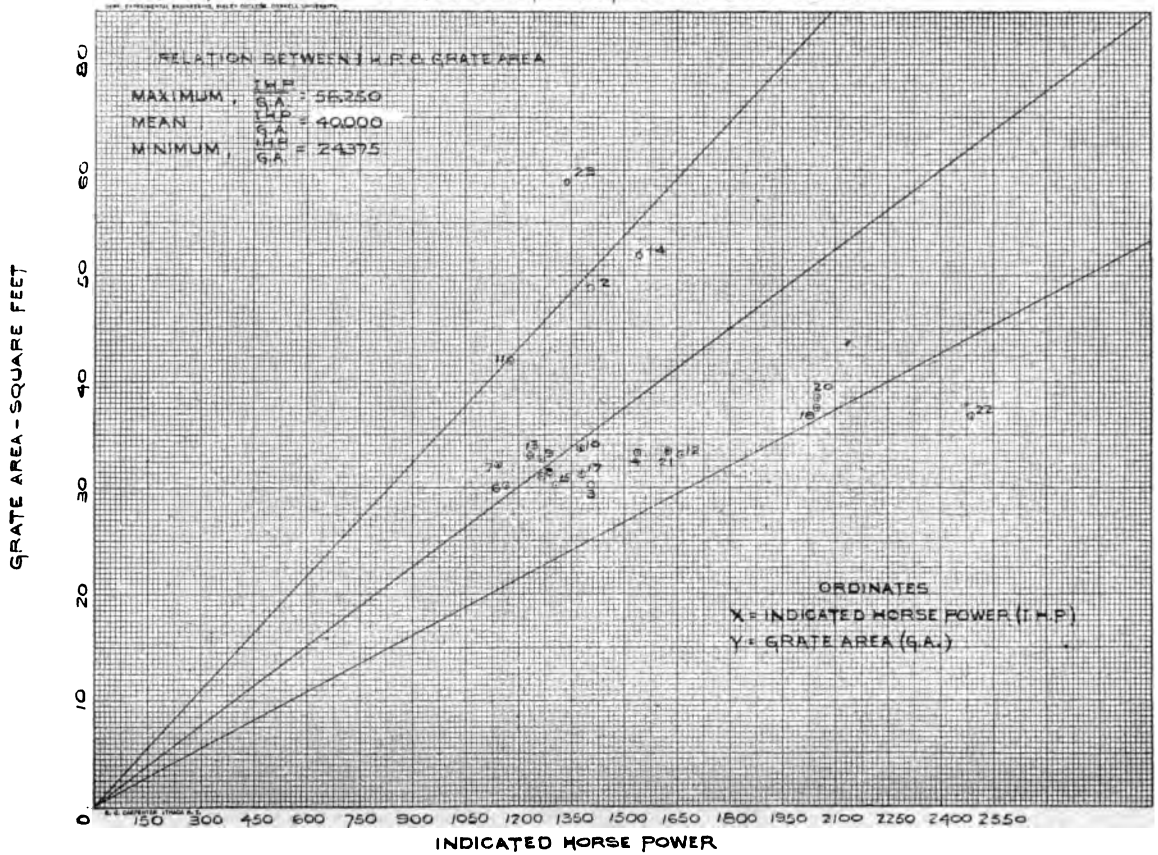


PLATE - XXII - COMPOUND PASSENGER ENGINES - BITUMINOUS COAL
RELATION BETWEEN INDICATED HORSE POWER & GRATE AREA
MAXIMUM, I.H.P./G.A. = 48.
MEAN, I.H.P./G.A. = 36.
MINIMUM, I.H.P./G.A. = 30
ORDINATES
X = INDICATED HORSE POWER (I.H.P.)
Y = GRATE AREA (G.A.)
0 150 300 450 600 750 900 1050 1200 1350 1500 1650 1800 1950 2100 2250 2400 2550
INDICATED HORSE POWER
0 10 20 30 40 50 60 80
GRATE AREA - SQUARE FEET

PLATE XXIII — SIMPLE FREIGHT ENGINES — BITUMINOUS COAL



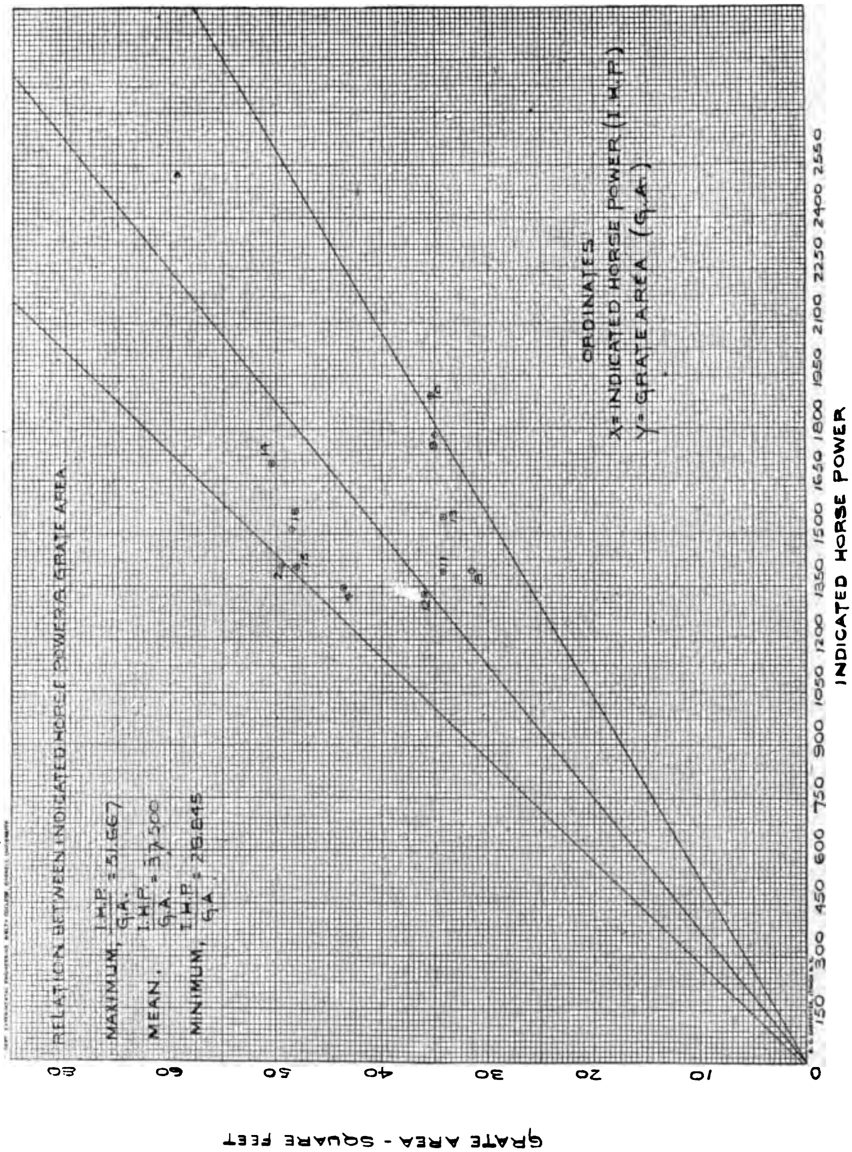


PLATE XXXIV - COMPOUND FREIGHT ENGINES - BITUMINOUS COAL

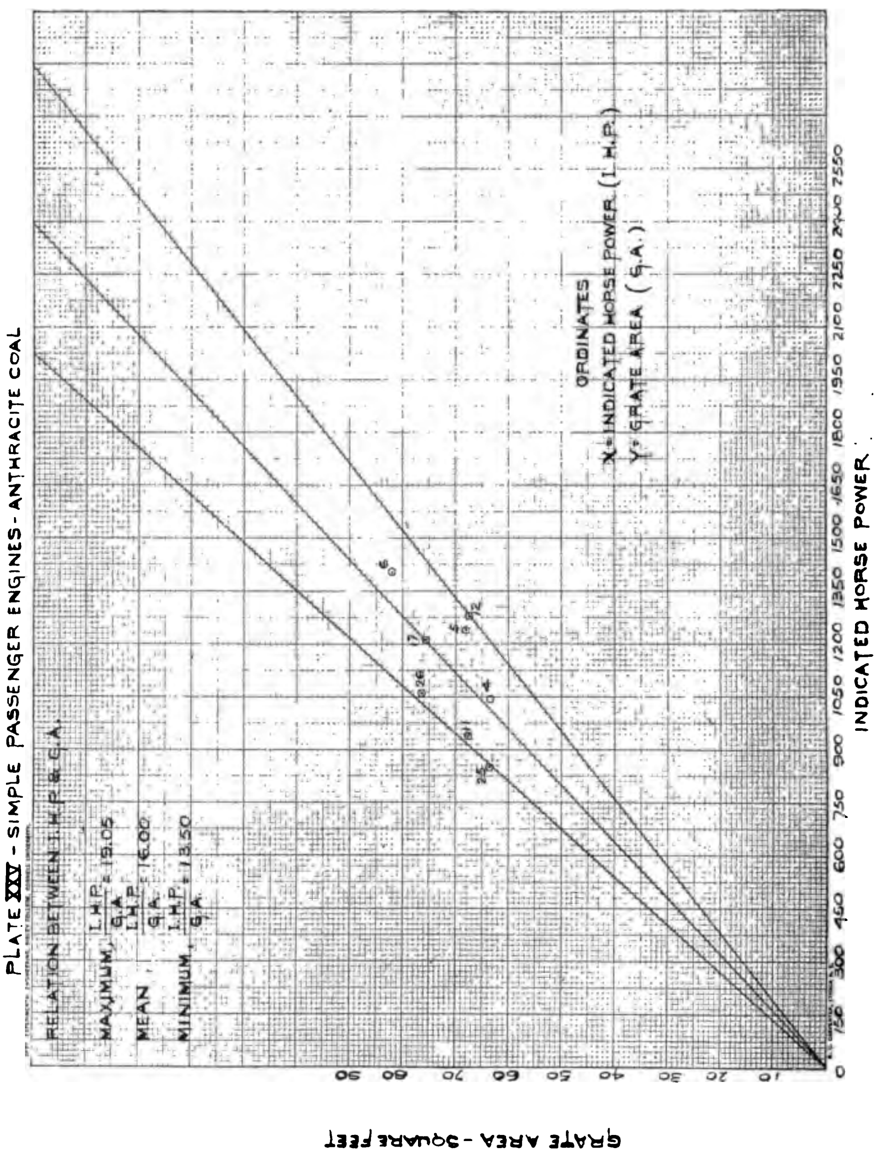


PLATE XXV - SIMPLE PASSENGER ENGINES - ANTHRACITE COAL
RELATION BETWEEN I.H.P. & G.A.
MAXIMUM, I.H.P./G.A. = 19.05
MEAN, I.H.P./G.A. = 16.00
MINIMUM, I.H.P./G.A. = 13.50
ORDINATES
X = INDICATED HORSE POWER (I.H.P.)
Y = GRATE AREA (G.A.)
0 150 300 450 600 750 900 1050 1200 1350 1500 1650 1800 1950 2100 2250 2400 2550
INDICATED HORSE POWER
10 20 30 40 50 60 70 80 90
GRATE AREA - SQUARE FEET

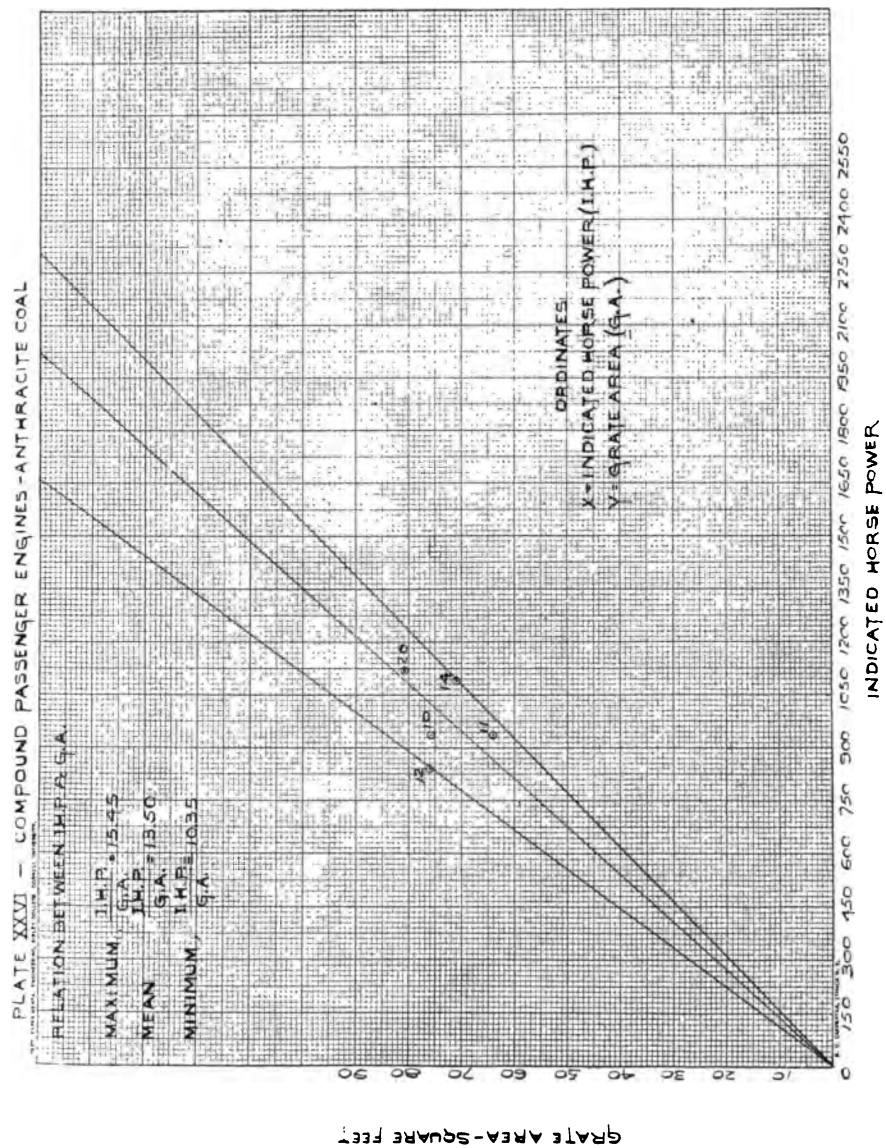


PLATE XXVI - COMPOUND PASSENGER ENGINES-ANTHRACITE COAL
RELATION BETWEEN I.H.P. & G.A.
MAXIMUM, I.H.P./G.A. = 15.45
MEAN I.H.P./G.A. = 13.50
MINIMUM, I.H.P./G.A. = 10.35
ORDINATES
X = INDICATED HORSE POWER (I.H.P.)
Y = GRATE AREA (G.A.)
0 150 300 450 600 750 900 1050 1200 1350 1500 1650 1800 1950 2100 2250 2400 2550
INDICATED HORSE POWER
0 10 20 30 40 50 60 70 80 90
GRATE AREA-SQUARE FEET

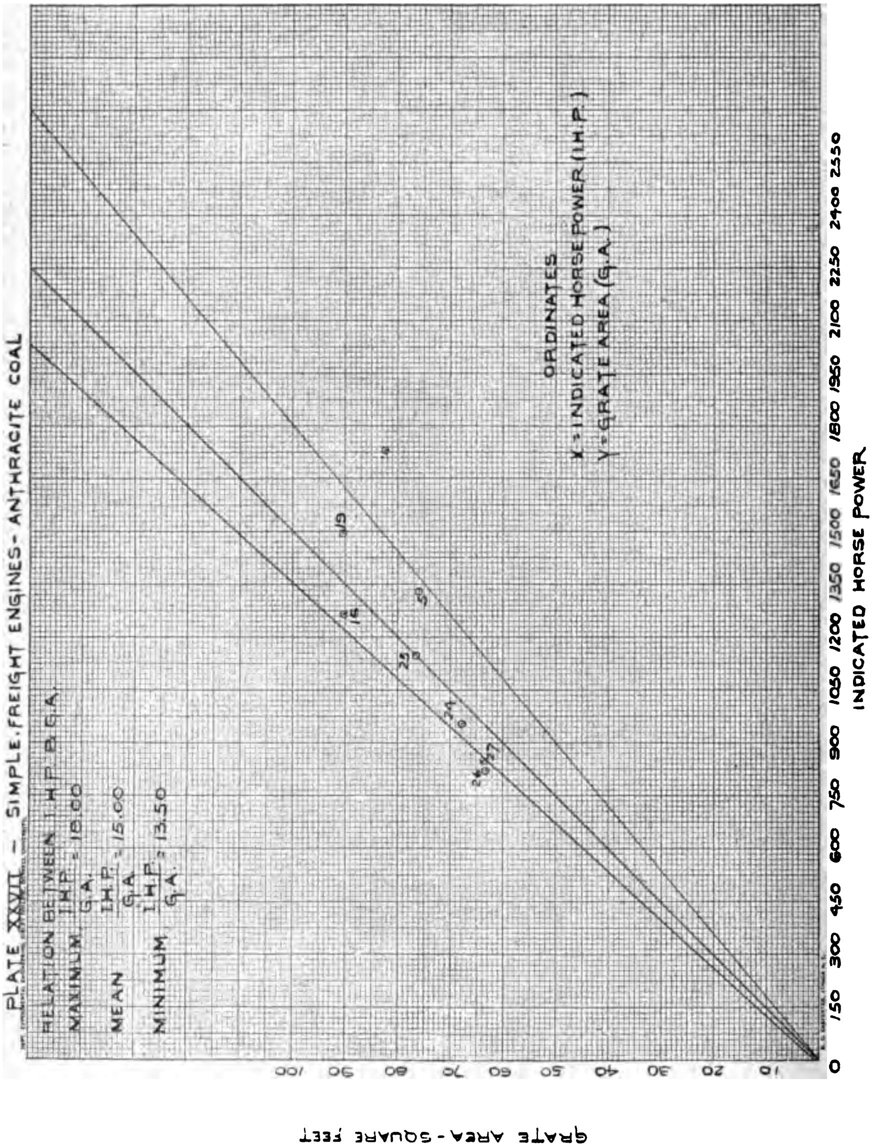
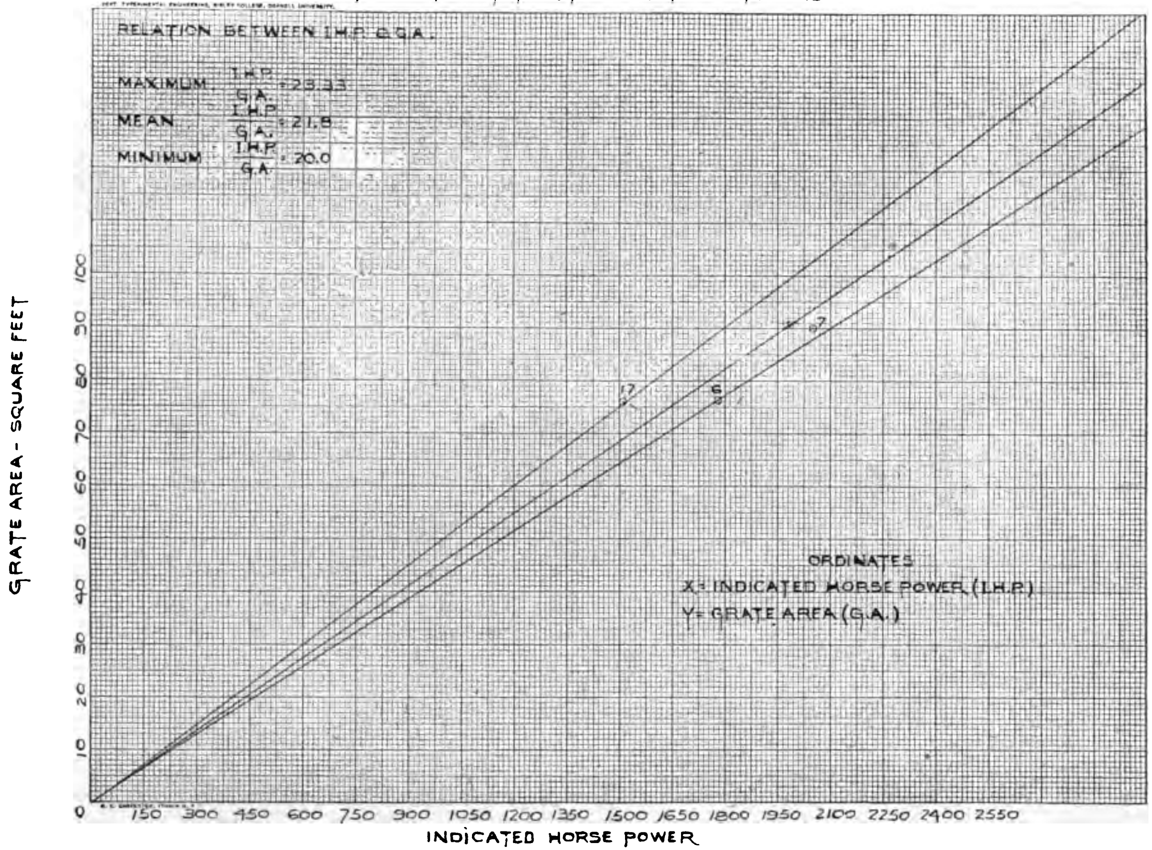


PLATE XXVII — SIMPLE FREIGHT ENGINES - ANTHRACITE COAL
RELATION BETWEEN I.H.P. & G.A.
MAXIMUM I.H.P./G.A. = 18.00
MEAN I.H.P./G.A. = 15.00
MINIMUM I.H.P./G.A. = 13.50
ORDINATES
X = INDICATED HORSE POWER (I.H.P.)
Y = GRATE AREA (G.A.)
0 150 300 450 600 750 900 1050 1200 1350 1500 1650 1800 1950 2100 2250 2400 2550
INDICATED HORSE POWER
10 20 30 40 50 60 70 80 90 100
GRATE AREA - SQUARE FEET

PLATE XXVIII - COMPOUND FREIGHT ENGINES - ANTHRACITE COAL



SUMMARY OF RESULTS OBTAINED.

KIND OF ENGINE.		Simple Passenger	Compound Passenger	Simple Freight.	Compound Freight.
TOTAL HEATING SURFACE. / Max. Ind. Horse-power or number of feet of Heating Surface per I. H. P.	Maximum	2.39	2.58	2.30	2.15
	Mean	2.00	2.13	1.71	1.80
	Minimum	1.72	1.70	1.48	1.58
TOTAL HEATING SURFACE. / Grate Area or number of feet of Heating Surface per square foot of Grate Area	Very free-burning bituminous	65 to 90	75 to 95	70 to 85	65 to 85
	Average bituminous coal	50 " 65	60 " 75	45 " 70	50 " 65
	Slow-burning bituminous or mixture of anthracite and bituminous	40 " 50	35 " 60	35 " 45	45 " 50
	Slack bituminous, mixtures of anthracite and bituminous, and free-burning anthracite	35 " 40	30 " 35	30 " 35	40 " 45
	Very low grade bituminous, lignite, mixtures of anthracite and bituminous and slow-burning anthracite	28 " 35	24 " 30	25 " 30	30 " 40

MAX. IND. HORSE-POWER. / Grate Area, or I. H. P. per square foot of Grate Area	Very free-burning bituminous	35 to 45	40 to 48	45 to 55	40 to 50
	Average bituminous	30 " 35	35 " 40	35 " 45	33 " 40
	Slow-burning bituminous or mixture of anthracite and bituminous	25 " 30	30 " 35	25 " 35	29 " 33
	Poor bituminous, or mixture of anthracite and bituminous	19 " 25	16 " 30	18 " 25	24 " 29
	Stack bituminous, mixture of anthracite and bituminous, free-burning anthracite	16 " 19	14 " 16	16 " 18	22 " 24
	Very low grade bituminous, lignite, mixtures of anthracite and bituminous, slow-burning anthracite	13 " 16	10 " 14	13 " 16	20 " 22
TUBE HEATING SURFACE. / Fire-Box Heating Surface, or number of square feet of Tube Heating Surface per square foot of Fire-Box Heating Surface	Maximum	16.67	18.56	18.50	17.56
	Mean	13.42	13.42	12.75	13.58
	Minimum	10.25	10.09	9.04	11.50
TOTAL WEIGHT OF ENGINE. / Max. Ind. Horse-power, or weight (in lbs.) per I. H. P.	Maximum	145.00	165.00	142.50	127.50
	Mean	127.00	135.00	115.50	113.25
	Minimum	108.00	111.00	101.25	102.25

On motion the report was received and opened for discussion.

MR. DAVID VAN ALSTINE: Referring to the first recommendation of the committee that we give the relation between the indicated horse-power and the total heating surface, it seems to me that relation cannot be a constant throughout the country. On roads where bad water is used they must allow more heating surface per indicated horse-power than on roads with good water, and if that is true in this case, it will also be true of recommendation No. 2, that the bad water district must have a greater weight of engine per given horse-power to make a satisfactory boiler. I think it would be a good plan, in case this committee is continued or a new one appointed, to ask the committee to include in its report such information as it can obtain, showing the weights of boilers of different horse-power; that is, what percentage of the total weight of the engine the boiler is and what percentage the machinery is, and then we can see how much the boiler weighs per indicated horse-power in bad water districts and how much in good water districts.

MR. GAINES: I might refer the gentleman to plate 1, under the heading of "Simple Passenger Engines." These engines cover pretty equally the whole United States, bad water districts and good water districts, and the uniformity and the narrow limits given for that ratio seems to show that the thing lies in a pretty well defined group all over, irrespective of the kind of service and where it is used. Take a simple passenger engine and the limits are very narrow between which these constants vary. Referring to plate 13, for weight of simple passenger engines, you will observe the total number of engines plotted falls within a narrow limit and the variation is much smaller than one would be led to expect. While there is some variation due to local conditions, yet as a general comparison, it will not be found to vary as much as might be expected.

MR. C. A. SELEY: In view of what Mr. Van Alstine said it seems to me that the good coal and bad coal districts would be more important than the good water and bad water districts, and as Mr. Gaines points out the actual limits covering the practice in good and bad coal districts, as well as good and bad water districts it seems to me it would be an endorsement of this plan by

SHEET No. 1 — SIMPLE PAS

Tube Heating Surface, sq. ft.	Total Heating Surface, sq. ft.	Grate Area, sq. ft.	Total Weight.
3298	3478	50.3	1760
2817	3016	46.2	1620
2223	2423	29.92	1595
2081	2230	63.3	1409
2104.4	2320.4	68.0	1734
2793	2967	82.2	190
3169	3343	48.5	174
2805.6	3007.9	54.43	173
2474	2640	55.5	176

cation of the work to which I refer, it has been subjected to some criticism, the claim being that my estimate of the power is in excess of that which engines are capable of giving; one critic claiming that they were at least 50 per cent. too high. I think it is true that many of our large engines give results in everyday service which fall far below those estimated by Mr. Gaines' ratios as well as by the ratios which I employed. But I do not think that such service measures the capability of the engines, and so I hold that Mr. Gaines is correct in the values he has chosen, and that I also was not in error in my published statement. I believe this because when the large engine is put to the same intensity of action as that which characterizes the operation of the small engines, then we shall find they will give results comparable to those presented in the report.

The fact is, however, that, comparatively speaking, the large engines are not being worked as hard as the small engines because it is not possible to fire them as hard. In accelerating trains, in getting out of stations, and for all short heavy pulls for which the firing does not need to be proportionate to the output of power, the large engine works up to its maximum power and it is worth all it costs for the service it gives on these occasions, but as a rule, in continuous service, they are not being worked to their full power, but this statement does not discredit the large engine nor the statements of Mr. Gaines concerning them. It merely calls attention to an operating condition which sometimes leads people to be deceived concerning the real power of the machines with which they deal.

With reference to one detail, the use of the symbol "I. H. P.", I should prefer to see that symbol confined to measures of power actually obtained from the indicator. I think it is a mistake to call a value "indicated horse-power" when it is not obtained by means of the indicator, but is really an estimated power. In a discussion of similar relations before the New England Railway Club recently, I was careful to use the symbol "C. H. P.", cylinder horse-power, which I assumed to be the equivalent of the indicated horse-power, but since the values it represents were not directly dependent upon the indicator, I refrained from calling it indicated horse-power.

Mr. G. W. West: The road with which I am connected built

some 100-ton engines, and our experience endorses fully what Professor Goss has said. When we first obtained the engines we used them entirely in the pushing service, and they came up to our expectations and fully developed the power represented by the ratios. After we had a sufficient number of the engines to use them on a division of 150 miles, we could not get the results as in the pushing service, from the fact that they could not be kept hot.

MR. H. H. VAUGHAN: I will call attention to the fact that this report recommends a new ratio between heating surface and horse-power, superseding the recommendation of the 1897 report, which was the ratio between cylinder volume and heating surface. The 1897 report contained a large amount of information, and if this ratio is adopted we shall have two ratios running, the one being indicated horse-power to heating surface and the other being the ratio between cylinder volume and heating surface, as in the 1897 report. If you will look at recommendation 1, here represented, you will find the method recommended by this committee is identical with that adopted by the 1897 committee; in other words, the size of the driving wheels is eliminated, because we are considering a certain number of revolutions per minute in this report, as was considered in the 1897 report.

The one fact different in this report is the question of boiler pressure, and as this question is of very doubtful correctness, as we do not at present know enough about the efficiency at different pressures to say whether they should be a factor in this quantity, I think it is a mistake to change from the ratio that was established in 1897, and practically do away with all the information in that report. This is introducing a new ratio. The old one was that of cylinder volume and square feet of heating surface. It might as well have been the diameter of cylinder squared multiplied by stroke, or anything else when a certain ratio is established. This is introducing a new ratio practically, and I do not think there is any advantage in so doing. It is no more a measure of the horse-power than the old method.

(Vice-President West in the chair.)

MR. M. N. FORNEY: The paper before the Association brings up a subject I remember having discussed many times during the past thirty years, or more; and I can recall a paper on somewhat

the same subject which was read quite a number of years ago, which caused a discussion similar to this, except at that time we had not so many members of the Association who had received the advantage of a technical education. There was a formula proposed in the paper to give the proportionate heating surface to the power, weight and capacity of the engine. After the discussion had gone on some time some one said there was a simpler formula than the one proposed to determine the amount of the heating surface and that was to make the boiler as large as possible. The principle may safely be laid down, that between the limits of weight and space to which you are confined you cannot make a boiler too big. I believe that is a sound principle. The other question which is brought up to-day in this paper is the relation of the grate surface to the heating surface. The new forms of construction and the wide fire boxes which are now used make it possible for us to proportion the grate to the heating surface, whereas in the old forms of engines, where the fire box was placed between the wheels or between the frames, it is not possible to get as much grate surface as we might desire.

My attention was called to this subject some years ago, and it seemed to me that the matter of grate surface stood somewhat in this way: that when an engine is worked very hard you need a great deal of grate. When the engine is not worked so hard you do not need so much grate, and therefore that the live portion of the grate should be adjusted to the work which the engine has to do, and with that object in view I designed a grate and patented it. I will say that there is one peculiarity about the things which I patent—their merits are not recognized until the patent expires, and this patent has nearly expired, so that you will be safe in using it.

Mr. A. M. Waitt: Mr. Chairman, I will say a word on this report. I believe it is desirable to get at things in the simplest way possible. Although I used to have a great deal to do with formulæ and algebraic symbols, etc., I like to get away from them as far as I can. As I stated yesterday, in my remarks at the opening of the convention, I have been giving quite a little thought and study to the figuring of ratios of heating surface to the power developed by engines, and I was much interested, the other day,

in looking over the detailed dimensions of quite a number of locomotives, published in one of the railroad journals, which gave a tabular comparison of notable examples of recent locomotives; and, although many of these locomotives were designed, and the heating surface proportioned quite closely to the formula laid down in 1897, and a great many locomotives have been designed since that time, yet I know as an actual fact that many engines designed on the basis of that formula are poor steamers in service. I have been tracing this a long time, to see if I could get at any way of avoiding the difficulty that others have run into.

I do not know that I have, but I know this, that there is a radical difference in some engines that have been built by several roads during the past year and a half, in the fact that though the weight on drivers is practically the same as those designed by other roads, yet they steam well in service, they take the trains over the road, work hard or easy and still have an abundance of steam, with the fireman not overworked, but yet having plenty to do (because with the large engines, no matter how wide or short the fire box is, the fireman is closely to the limit of what he can do). Yet in the case of the other engines I speak of, designed apparently in accordance with the formula in the 1897 report, they do not steam. What is the difference? I find in looking over this table that I referred to a moment ago, that there is a very great difference in passenger engines and in freight engines in the ratio between what I consider as a fair indicator of the power of the engine, that is, the weight on the drivers and the total heating surface. Whether compound, tandem compound, four-cylinder compound, simple engine, or anything else, always the weight of the drivers indicates the maximum power you can get out of the engine.

It does not require any figuring or algebraic formula or anything of that kind to show that the weight of the drivers is the basis of the power you are going to develop. How are you going to get the power? You must have the steam. It seems to me if you take the ratio of these indications of the power to be obtained from the engine, the weight on the drivers, and the heating surface under the boiler, these two features give you the keynote to the situation and give you just what you want to arrive at. On passenger engines I find in this list that the ratios are running all the way from as high as 1 to 45.9, down to as low as 1 to 27.

That is quite a variation, and it is as certain as the sun is shining to-day that there are a number of these engines which when put behind heavy passenger trains, cannot make the steam and get the trains over the road. There are others of them, where the ratio is lower, which you can put behind an eight or ten-car train and they will go along and be popping off when they are doing their very hardest work.

It seems to me it is worthy of consideration whether there is not a simpler way of getting at the method necessary for determining how much heating surface you want as compared with the weight of the drivers, which indicates the maximum power you can get out of the engine. As I stated yesterday, I found the best ratio in any engine was 1 to 27. These engines, I know, are steaming admirably, whereas engines in the same service with a ratio of 1 to 45, cannot furnish the steam to do the work. In other service we require an entirely different ratio. With our freight trains we are taking ten hours to travel 150 miles, whereas in passenger service, we are doing it in three hours, and you must furnish steam in less time with passenger engines, so that with freight engines the ratio of the heating surface to the weight of the drivers can be higher. I give this as a suggestion worthy of consideration and as a simpler way than depending on any computations based on the size of the cylinder, or power of the cylinder, whether compound or simple, or whatever the engine may be.

MR. M. N. FORNEY: I make the inquiry as to whether our chairman ever saw a locomotive with too much heating surface?

MR. WAITT: I have never seen one yet, and the ratio I spoke of a moment ago as being a larger heating surface than I had seen before is true; but it is a question whether we are not approaching a point where we may possibly arrive at too much heating surface, but in my opinion we have not yet reached it.

MR. FORNEY: If there are no locomotives with too much heating surface, would it not be safe to adopt the rule to make it as big as we can?

MR. F. F. GAINES: I will say a few words in reply to Mr. Forney. Where you have an engine to design, that must perform a

certain amount of work, such as hauling a given train over a given division, where the grades and weight of train are known, in connection with a limiting driver weight laid down by the maintenance of way department, it is absolutely necessary to know the limits within which you must work in order to produce satisfactory results. If you have your boilers and cylinders designed to suit what you think the occasion demands, you may find that you exceed your weight, and that it is necessary to cut down the size of your boiler. If you know the limiting values of heating surface which can be used successfully, you have an option on two courses. You can either cut down the heating surface to a point at which you know from previous experience and derived ratios the boiler will not generate sufficient steam, and the other alternative is to come out frankly and state that the problem is impossible under the limiting circumstances.

Another question which President Waitt brought up was in regard to the 1897 ratios; that they have undoubtedly fallen behind what is modern practice. Naturally at that time, the ratio of great areas and heating surfaces were not what they are to-day. The question I would ask Mr. Waitt is, where you are preparing the amount of heating surface in regard to the weight on drivers, is not that apt to be deceptive when you come to engines with the traction increaser on them?

MR. WAITT: I neglected the traction increaser entirely, because that is used on starting trains when you are not furnishing steam rapidly. At high speeds the steam is furnished rapidly and then the traction increaser is not used.

(President Waitt in the chair.)

THE PRESIDENT: The committee has made certain recommendations. After the discussion which we have had, it is for the members to decide what action they will take in regard to these recommendations, as to whether they are advisable or not and whether the committee is to be continued.

MR. C. A. SELEY: As the development in heavy locomotives has been so very rapid, and as this formula contemplates a departure from the practice of not so long ago, I would move that the recommendation of this committee stand over for one year rather than that it shall be adopted at this time.

THE PRESIDENT: And the committee be continued?

MR. SELEY: Yes, sir.

MR. QUEREAU: It occurs to me that possibly the mover of the original motion will consider an amendment to the effect that the motion be that we simply close the discussion, without acting upon the recommendations of the committee, or if we should act upon them, do not accept the recommendations, rather than say we will pass on them a year from now. If we set the date, and we do not care to adopt the recommendations at that time we have gained nothing. As there was no second to Mr. Seley's motion, I would move that the report of the committee be received and placed upon the minutes, without any action on the report.

The motion was carried.

THE PRESIDENT: The next subject is an individual paper by Mr. L. R. Pomeroy, " A Typical Shop to Serve a Road on Division Equipped with 300 Locomotives." This paper shows a large amount of thought and work, and I know will meet with a hearty reception and will prove of great value. I trust, after Mr. Pomeroy has presented his paper that there will be a good discussion upon it.

Mr. Pomeroy presented the following paper:

A TYPICAL SHOP TO SERVE A ROAD OR DIVISION EQUIPPED WITH THREE HUNDRED LOCOMOTIVES.

BY L. R. POMEROY, GENERAL ELECTRIC CO.

(An associate member of the Association.)

" Keep thy shop and thy shop will keep thee."

" The true epic of our time is not the arms and the man, but tools and the man, an infinitely wider kind of epic."—*Carlyle.*

·oduction.

In undertaking the presentation of a few general thoughts on the foregoing subject, it is with the hope of stimulating discussion and bringing out from the members information and experience that will prove a valuable addition to the literature on the subject. If then the paper can be made the text and dissolved into the discussion, we venture to hope that the effort and tax on your valuable time may be considered justified.

portion of l operating ense for ch the I. P. is ›onsible.

The items of expense entering into the cost of operation, for which the Motive Power Department is more or less responsible, represents about 30 to 35 per cent of the total operating expenses, of which labor comprises 12½ per cent, fuel and lubrication 12.7 per cent and repairs 8.8 per cent. These items show the very narrow field or range in which the motive power officer must confine his efforts in seeking to effect economies in his department. As the question of repairs represents nearly

one-third of the items for which he is more or less accountable, the shop problem becomes quite important and worthy of careful attention.

Some gener principles.

"Division of labor is to-day recognized as an essential characteristic of manufacturing. It has been found that in no other way can production be made so rapid and so economical in material and labor. To produce a manufactured article, a number of processes are required, each different from the other; in appliances used and in the character of skill required of its working force, but all coöperating to the same end — the production of a single, complete, marketable article. In designing a manufacturing plant, it follows that this differentiation of appliances and manual skill must be recognized if the best use is to be made of the appliances and of the men. The railway shop plant is a kind of manufacturing plant, and the same principles which apply to the successful operation of other manufacturing plants apply to its operation.

How to best subserve his own particular conditions is then the thing which the motive power officer has to consider. The factors which enter into this problem are many, but we think they may be gathered under the following heads:

1. Convenience of location in respect to the accommodation of the system as a whole;

2. Convenience of location with respect to centers of supply of material and labor, and

3. Advantages of location in respect to cost of land, buildings, taxes, etc."

Defects in s design permanent.

Defects in shop design, causing inconvenient handling of material or movement of workmen, are permanent and can not be removed. From the time the raw material is taken in hand until it is erected in the finished locomotive, its movement should be directed to the end. Shops, therefore, should be so laid out that the proper sequence of operations can be followed so as to minimize labor and lessen cost of operation.

Governing consideratio presented b Western manufactur

Some general considerations governing the erection and design of new shops as laid down by a Western manufacturer are pertinent in this connection and are as follows:

First. The most suitable manufacturing building is a ground-floor surface, protected from the weather and direct rays of the sun, without interfering with the light.

Second. A plant started on a scale however small should be capable of indefinite extension without expense in altering or in any way interfering with previous construction.

Third. Land enough should be secured in the first instance to avoid the future necessity of removal and abandonment of a plant at a loss, owing to lack of room.

Fourth. With land at $2,000 per acre, or less than 5 cents per square foot, it is cheaper to use land for one-story buildings than to save land by building more than one story.

Fifth. It is cheapest to support machinery directly on the ground. There is no vibration, no danger of heavily loaded floors falling when

buildings are old, nor of upper floor loads falling upon the lower in case of fire.

Longitudinal track arrangement superior to transverse track form served by transfer table.

Perhaps it is not too much to claim that all are quite agreed that the arrangement of erecting shops with longitudinal tracks, when provided with conveniently appointed cranes, is superior to the old form of transverse track arrangement with the accompanying transfer table and the numerous doors opening thereon, even if a traveling crane is provided.

Design of shops with transverse tracks doing away with transfer tables and doors.

Recently, however, several shops have been designed on the transverse or across track plan, dispensing with the transfer table and attendant side doors for each pit. Sketch plans, made from published cuts, illustrating this latter form, are given herewith. Fig. 1, plan and section of erecting, machine and boiler shops of the L. S. & M. S. R'y, at Collingwood, Ohio; Fig. 2, section through erecting and machine shops of the P. & L. E. R'y, at McKee's Rocks, Pa.; and Fig. 3, plan and section of erecting and machine shops of the P. & R. R'y, at Reading, Pa.

L. S. & M. S.

P. & L. E.

The entrances to erecting shop shown on Figs. 1 and 3 are by means of turntables, while the shop represented by Fig. 2 is entered by means of switch tracks leading from the yard.

Figs. 4, 5 and 6 are presented as interesting examples of shop grouping, arranged for longitudinal tracks.

Fig. 4, design presented by one of the railway papers some ten or more years ago.

Fig. 5, a plan designed by Mr. M. N. Forney, and Fig. 6 shows a design by the late Howard Frye for the West Shore Road.

PLATE 1

Typical shop.

Is presented to show the author's idea of the typical shop designed to comply with the conditions indicated at the head of the paper. The erecting, machine and boiler shops are practically under one roof, compact and arranged to facilitate the handling of material, reducing to a minimum the distance to be traversed by both men and material.

Erecting shop

The longitudinal tracks in the erecting shop side are arranged to provide 25 feet between centers, enabling, when necessary and desirable, the placing of engines between the tracks, thereby adding to the normal capacity of the shop; the capacity rating of the erecting shop, however, is based on the track capacity only.

As noted on plan, the erecting shop is nominally 400 feet long, with a track capacity of twenty-four locomotives, allowing ample space at either end of shop and for a definite passageway between the head and rear ends of all engines standing on the tracks.

Cranes.

The cranes in erecting shop are in two units of sixty tons each, the combined capacity, when working in unison, enabling the handling of the heaviest type of locomotive in use at the present time.

As the cranes will not be utilized for lifting engines more than ten to fifteen per cent of the time, two cranes are available for general use, when not employed in lifting and traversing engines, and both cranes are provided with rapid auxiliary hoists.

The boiler shop being a continuation or extension of the erecting and machine shops, one of the erecting shop cranes is available for use in the boiler department, when desired, while the other can be usefully employed in facilitating the erecting of engines, and yet both can be brought directly into service in either place, as the dictates of necessity or utility require. **Boiler shop.**

The engines enter from the right, preferably by means of the center track, are lifted off their wheels and carried to any convenient or desired location. The wheels are then taken to the storage tracks provided, adjacent to the wheel and axle department, and receive attention in due course. **Movement of engines.**

The machine shop side is divided into two bays; the one on the outside for the lighter tools served by light traveling air hoists locally arranged, as the tools and departments naturally determine; while in the other, nearest the erecting tracks, are grouped the heavy tools. This latter bay is provided with two cranes of ten and five tons capacity, respectively. These cranes are provided with rapid hoists and serve all the tools in this bay, traversing the full length of the building and also available in the boiler end, serving the tools of this department and running clear into the riveting tower. **The machine shop.**

The question of tracks, both standard and industrial, should be considered and provided when necessary. **Material tracks.**

Steam and water pipes to be provided, running the entire length of the shop; also electric cables with numerous taps for portable lamps.

While no arrangement for lighting is shown on plans, yet the scheme comprehends an adequate electric lighting system, with the necessary generator for same. **Lighting.**

Compressed air mains to run lengthwise of the shop, and branch pipes attached to each post to run down to a point near the floor are shown. Numerous storage tanks located at convenient points should be provided to insure a steady and uniform pressure. **Compressed air.**

TOOLS.

" The electric motor has taken its place as one of the everyday, hard-working, steady-going, reliable pieces of apparatus that is to be counted on and used with the same freedom that a pulley or a block and tackle would be applied in its appropriate place in the construction of a modern industrial plant." **Method of driving.**

" Electric transmission places no restriction on the location of the machines, and each shop may be planned with a view of handling its product with least waste of labor and with greater convenience of access to the tools."

In order to insure the greatest amount of service from shop tools, a careful calibration and a predetermined rating of each is a *sine qua non.*

When the tools are carefully rated, and the best commercial speeds, as to feeds and cuts, covering the range of the tool with reference to the material and product desired, definitely determined, a more uniform output from similar machines and the maximum output from all the tools is assured. **Rating of tool**

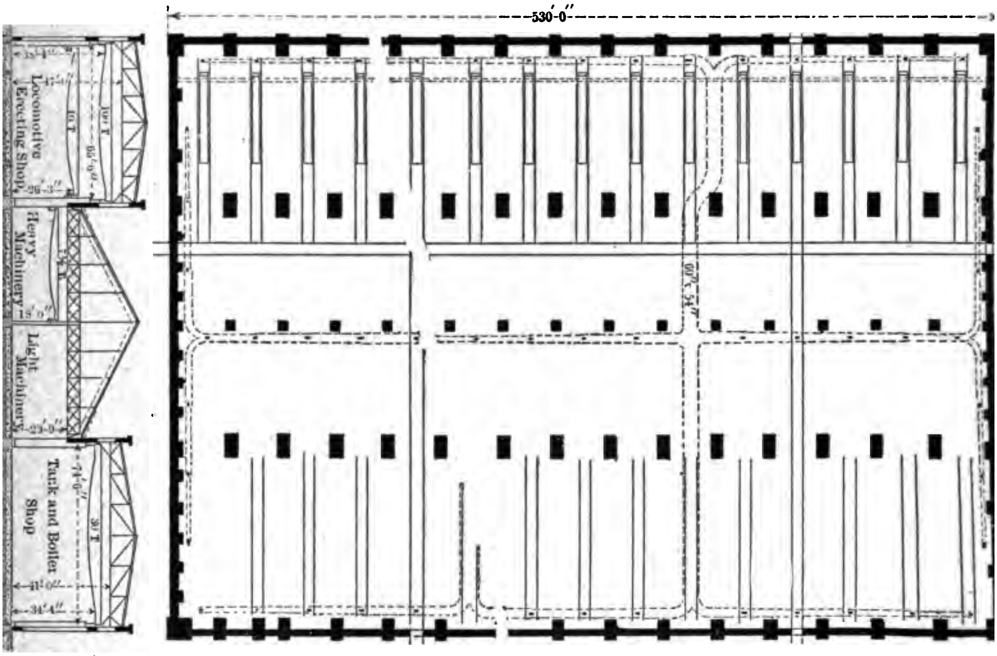

530'-0"
Locomotive Erecting Shop
Heavy Machinery
Light Machinery
Tank and Boiler Shop
54'-0"

FIG. 1.

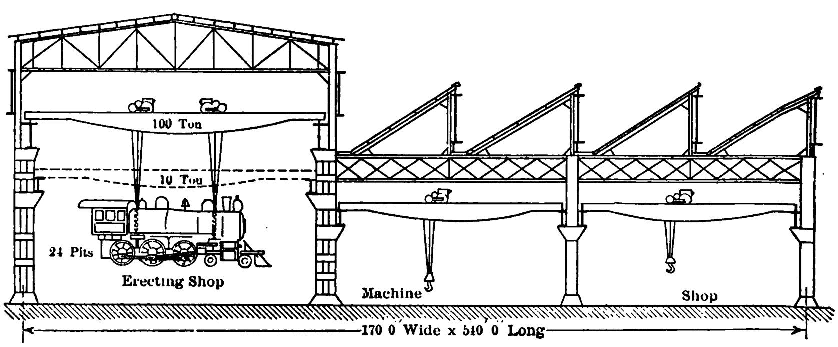

100 Ton
10 Ton
24 Pits
Erecting Shop
Machine
Shop
170 0 Wide x 510 0 Long

FIG. 2.

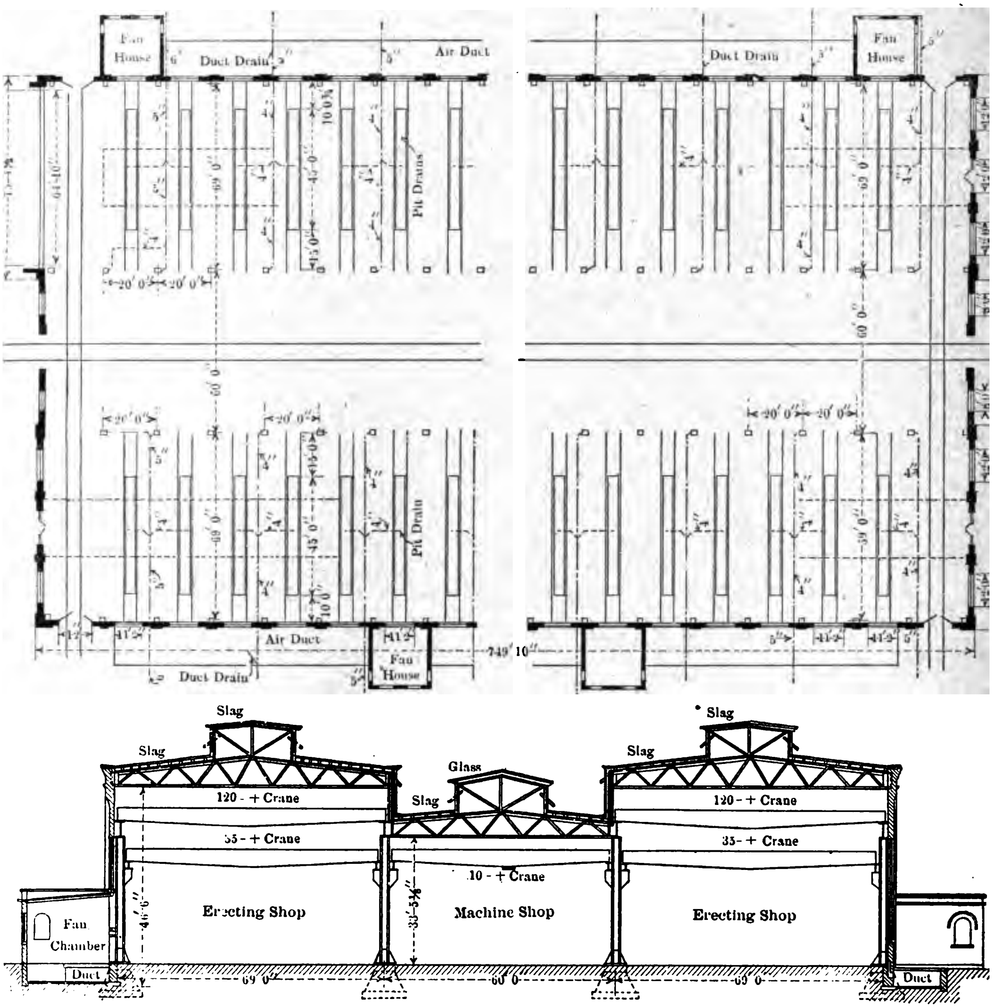
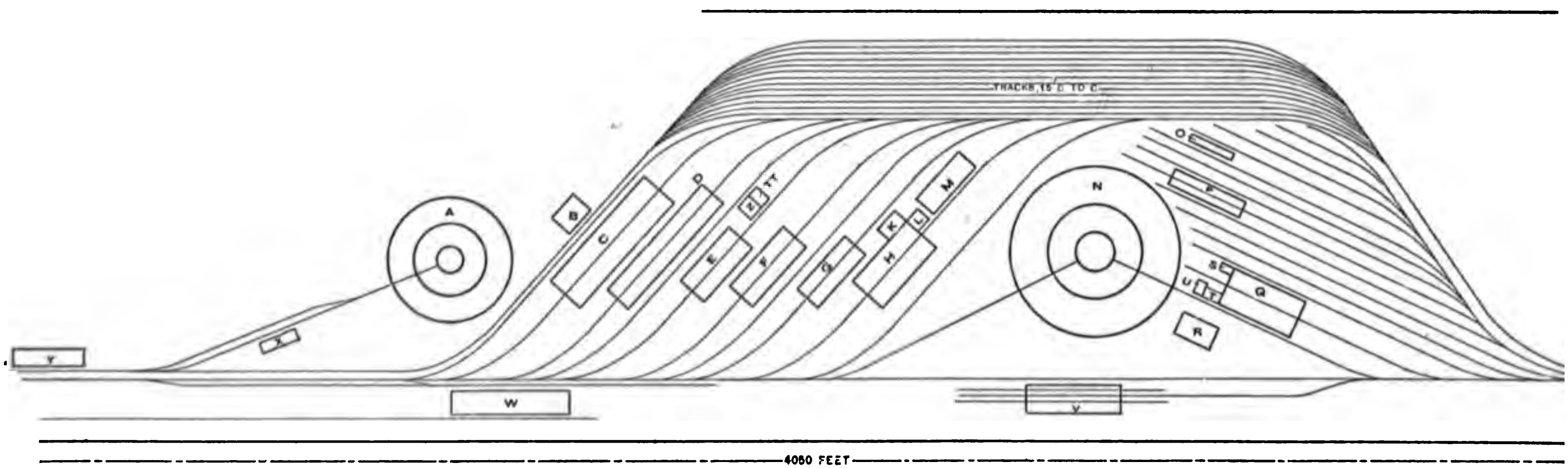

Fan House
Duct Drain
Air Duct
Pit Drains
Pit Drain
749' 10"
Slag
Glass
120 - + Crane
35 - + Crane
10 - + Crane
Erecting Shop
Machine Shop
Fan Chamber
Duct
69' 0"
60' 0"

FIG. 3.



A—Forty-stall roundhouse, 312 feet diameter. B—Oil house 60 by 80 feet. C—Machine shop, 300 by 100 feet. D—Engine erecting shop, 70 by 350 feet. E—Smith shop, 80 by 200 feet. F—Boiler shop, 80 by 200 feet. G—Truck, tin and copper shop, 70 by 180 feet. H—Foundry, 100 by 200 feet. K—Brass foundry, 40 by 65 feet. L—Cleaning shed, 40 by 50 feet. M—Pattern house, 60 by 150 feet. N—Car erecting shop, 426 feet diameter, 50 stalls. O—Dry kiln, 20 by 120 feet. P—Dry lumber shed, 30 by 200 feet. Q—Planing mill, 100 by 200 feet. R—Cabinet 60 by 100 feet. S—Engine room, 22 by 42 feet. T—Boiler house, 26 by 46 feet. U—Coal bin and shaving tower, 31 by 37 feet. V—Paint shop, 70 by 240 feet. W—Storehouse, 60 by 300 X—Sandhouse, 30 by 120 feet. Y—Coal chute, 50 by 180 feet. Z—Boiler house, 40 by 50 feet. TT—Coal bin, 30 by 50 feet.

FIG. 4.

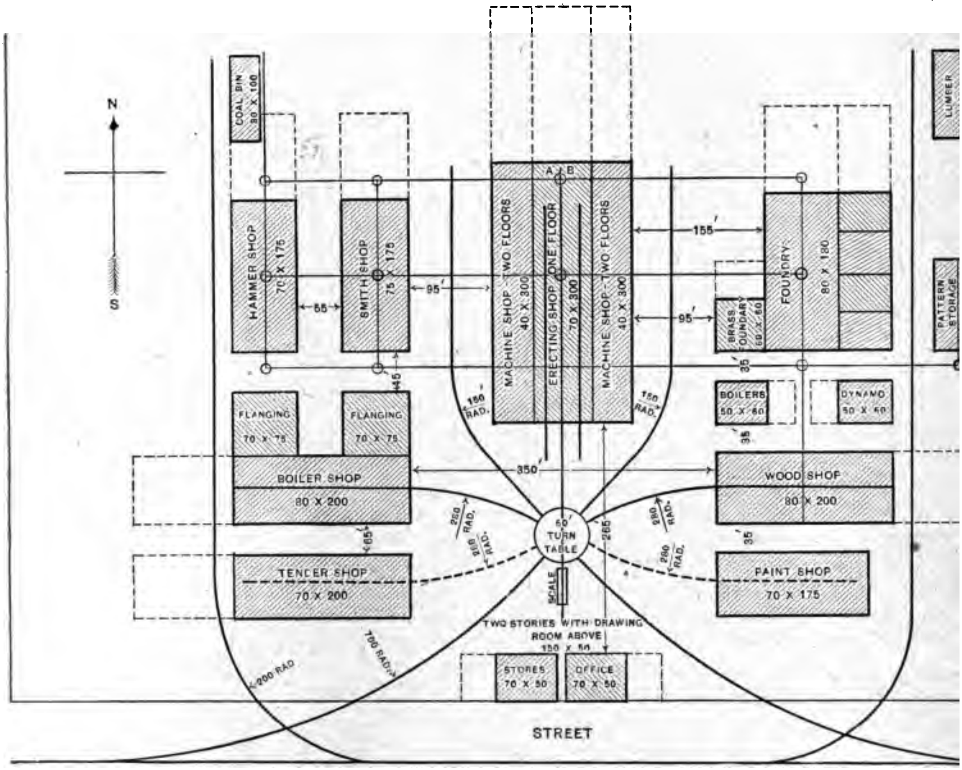

N
S
COAL BIN 30 X 100
HAMMER SHOP 70 X 175
SMITH SHOP 75 X 175
MACHINE SHOP - TWO FLOORS 40 X 300
ERECTING SHOP ONE FLOOR 70 X 300
MACHINE SHOP - TWO FLOORS 40 X 300
FOUNDRY 80 X 180
BRASS FOUNDARY 50 X 50
LUMBER
PATTERN STORAGE
BOILERS 50 X 60
DYNAMO 50 X 50
FLANGING 70 X 75
FLANGING 70 X 75
BOILER SHOP 80 X 200
WOOD SHOP 80 X 200
TENDER SHOP 70 X 200
PAINT SHOP 70 X 175
50' TURN TABLE
SCALE
TWO STORIES WITH DRAWING ROOM ABOVE 150 X 50
STORES 70 X 50
OFFICE 70 X 50
STREET
200 RAD.
700 RAD.
150 RAD.
250 RAD.
260 RAD.
350
155
95
65
45
35
265

FIG. 5.

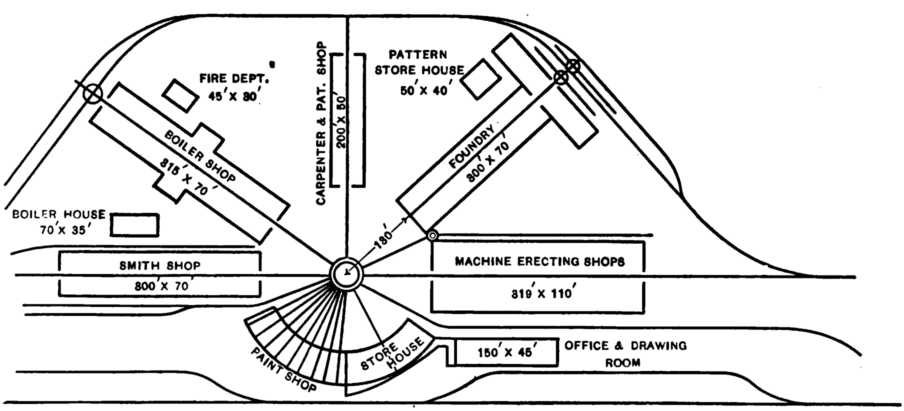

FIRE DEPT. 45' X 30'
CARPENTER & PAT. SHOP 200' X 50'
PATTERN STORE HOUSE 50' X 40'
BOILER SHOP 815' X 70'
FOUNDRY 800' X 70'
BOILER HOUSE 70' X 35'
SMITH SHOP 800' X 70'
MACHINE ERECTING SHOPS 319' X 110'
180'
PAINT SHOP
STORE HOUSE
150' X 45'
OFFICE & DRAWING ROOM

FIG. 6.

A plate giving this information attached to each tool places this information before the operator, so that no uncertainty as to which speed or cut to use to perform a given operation is possible.

The question of the limitations of life of a given tool is a subject often discussed, and the following extracts from the technical press are directly to the point:

When should tool be replaced?

"Tools are not up to date when there is something else on the market which will do more work or do it at less cost for labor. They need not necessarily be worn out to be wasteful by comparison."

"In England the decision was to keep the old machinery turning over as long as it could be made to do its work. With us the decision was to make scrap of it as soon as a newer machine could be found which would produce sufficient increase of product to pay the required interest on the investment. And be it observed, the fundamental conditions were more favorable to frequent renewals in England than here, for until recently rates of interest have been uniformly lower there than here, while the cost of machinery there has called for a smaller outlay for a given equipment. In our rolling mills and steel works it is, we believe, a conclusion to which engineers have arrived that provision must be made for renewing them *in toto* every ten years, and, in point of fact, we not long ago saw a rolling mill (by which term we now mean a set of rolls with its attached engine and appurtenances) which was in process of demolition and on its way to the cupola. That mill, we were told, had been built but five years before, to be, as it then was, a strictly modern and up-to-date mill, but the progress of improvement had made its demolition a necessary measure of economy."

This incident illustrates the American view of such matters. Not all American works have been so managed, but those that have not have been crowded to the wall by those that have. And it may be predicted with entire confidence that the process that has been at work between individual establishments will also operate between nations. It is a matter of easy proof — in fact, it is almost self-evident — that the American practice leads to the best use of capital, as well as labor, and that it must survive.

The English idea seems to be to regard a machine, once bought, as a permanent investment, or at any rate as one which is to be extinguished only by the operation of a suitable depreciation charge applied year by year.

Tool list.

Following is a list of tools with approximate power ratings for use in the application of electric motors, either on the basis of individual or group driving:

TOOL LIST FOR THE TYPICAL SHOP.

MACHINE SHOP.

DRILL PRESSES.

H. P.		
5	1	72-inch radial drill press, heavy, with tapping attachment.
3	1	60-inch radial drill press, heavy.
3	1	60-inch radial drill press, heavy.
2	1	48-inch radial drill medium, with tapping attachment.
3	1	40-inch upright drill press, heavy, compound table.
3	1	40-inch upright drill press, heavy, round table.
3	1	40-inch upright drill press, heavy, round table.
2½	1	36-inch upright drill press, heavy, compound table.
2½	1	36-inch upright drill press, heavy, round table, tapping attachment.
2	1	30-inch upright drill press, heavy, round table, tapping attachment.
2	1	30-inch upright drill press, heavy, round table.
2	1	20-inch upright drill press, light, not back-geared.
2	1	20-inch upright drill press, light, not back-geared.
2	1	Cotter drilling machine.
37	14	

All drill presses, except 20-inch, to have back gears. All spindles to have holes for drill sockets to Morse standard taper and fitted with standard keys for driving drills, instead of by flats. Standard sockets and drift keys to be used throughout, and interchangeable.

GRINDING MACHINES.

H. P.		
1	1	grinder for axle journals.
3	1	Landis grinder for piston rods, etc.
3	1	surface grinder.
5	2	20-inch wet tool grinders.
1	1	12-inch wet tool grinder for brass room.
½	1	small emery wheel tool grinder for brass room, No. 1 Brown & Sharpe.
3	1	flexible swinging grinding and polishing machine for rods.
1	1	large grindstone for finishing work.
2½	1	large buffing and polishing wheel.
25	10	

WHEEL DEPARTMENT.

H. P.		
7.5	1	84-inch 300-ton wheel press.
5	1	42-inch 200-ton wheel press — wheel presses to be provided with H. D. Gordon's patent hydraulic attachment for raising and

lowering to provide adjustment for height for various diameters of wheels to enable same to be rolled directly into wheel press from floor without hoisting.

5 1 driving wheel quartering machine, with attachment for turning crank pins.

—— —

17.5 3

PLANERS.

(To be provided with magnetic clutches for reversing.)

H. P.

15 1 60 by 60 inch by 28 feet table.

15 1 54 by 52 inch by 24 feet table.

10 1 42 by 42 inch by 16 feet table.

7.5 1 38 by 38 inch by 10 feet table.

7.5 1 36 by 36 inch by 10 feet table.

7.5 1 36 by 36 inch by 10 feet table.

5 1 30 by 30 inch by 8 feet table.

15 1 72 by 72 inch by 14 feet table.

—— —

82.5 8

SHAPERS.

2 1 traveling head shaper, 16-inch stroke, 8-ft. traverse.

2 1 16-inch stroke shaping machine.

2 1 14-inch stroke shaping machine.

2 1 12-inch stroke shaping machine.

5 1 Richards planer, 20 by 60 inches (open side).

—— —

13 5

SLOTTING MACHINES.

H. P.

7.5 1 18-inch slotting machine.

5 1 14-inch slotting machine.

3 1 10-inch slotting machine.

2-10 1 double head frame slotting machine.

5 1 Colburn key-seating machine, for driving wheels, etc.

—— —

40.5 5

BORING MILLS.

H. P.

7.5 1 84-inch boring and turning mill, two heads (wheel dept.).

5 1 62-inch boring and turning mill, two heads.

5 1 37-inch boring and turning mill, two heads.

5 1 37-inch boring and turning mill, two heads.

5 1 30-inch horizontal boring and drilling machine, 30-inch traverse of spindle.

7.5 1 cylinder boring machine.

—— —

35 6

MILLING MACHINES.

H. P.		
10	1	Heavy vertical milling machine, table fixed for height, head adjustable for vertical range of 24 inches. Round table with circular power feed and compound cross feeds; water groove cast on edge of round table; water pump; also light crane, 6-ft. jib, to swing around spindle, for rods, etc.
7.5	1	Vertical milling machine, with vertical adjustment similar to No. 6 Becker-Brainard.
15	1	Heavy slab milling machine, 10-ft. tables for rods; also with quartering centers for milling keyways in driving axles.
5	1	Universal milling machine (Cincinnati).
4	1	plain horizontal milling machine, No. 7 Becker-Brainard.
3	1	two-spindle light special milling machine for nuts and squares on brass work.
2.5	1	small, plain milling machine for brass work.
47	7	

LATHES.

7.5	1	90-inch driving wheel lathe (wheel dept.).
7.5	1	90-inch driving wheel lathe, (wheel dept.).
7.5	1	80-inch driving wheel lathe (wheel dept.).
5	1	42-inch truck-wheel tire-turning lathe, heavy (wheel dept.).
5	1	axle lathe, single, heavy, for driving axles (wheel dept.).
32.5	5	

LATHES.

H. P.		
5	1	axle lathe, double head (wheel dept.).
5	1	48-inch swing, 14-ft. bed, engine lathe, heavy.
3	1	36-inch swing, 16-ft. bed, engine lathe, heavy.
3	1	36-inch swing, 14-ft. bed, engine lathe, heavy.
3	1	30-inch swing, 12-ft. bed, engine lathe, heavy.
3	1	30-inch swing, 12-ft. bed, engine lathe, heavy.
2	1	28-inch swing, 12-ft. bed, engine lathe, heavy.
2.5	1	26-inch swing, 8-ft. bed, engine lathe, heavy (wheel dept.).
2.5	1	26-inch swing, 12-ft. bed, engine lathe, heavy, Bullard.
2.5	1	26-inch swing, 14-ft. bed, engine lathe, heavy, Bullard.
2.5	1	24-inch swing, 20-ft. bed, engine lathe, heavy, Bullard.
2.5	1	24-inch swing, 12-ft. bed, engine lathe, heavy, tap. attachment.
2	1	20-inch swing, 10-ft. bed, engine lathe, medium.
2	1	20-inch swing, 10-ft. bed, engine lathe, medium, tap. attachment.
2	1	18-inch swing, 10-ft. bed, engine lathe, medium, tap. attachment.
2	1	18-inch swing, 10-ft. bed, engine lathe, medium.
2	1	18-inch swing, 8-ft. bed, engine lathe, medium.

2	1	18-inch swing, 8-ft. bed, engine lathe, medium, tap. attachment
2	1	18-inch swing, 8-ft. bed, engine lathe, medium, tap. attachment.
2	1	18-inch swing, 8-ft. bed, engine lathe, medium, tap. attachment.
2	1	16-inch swing, 8-ft. bed, engine lathe, medium.
3	4	2 by 24 inch swing Flat turret lathes.
3	1	21-inch Bullard heavy screw machine.
1	1	20-inch Universal Monitor lathe for brass work.
2	1	18-inch Universal Monitor lathe for brass work, chasing bar with taper attachment.
2	1	16-inch Fox lathe with turret.
2	1	16-inch sq. arbor Fox lathe.
2	1	12-inch speed lathe.
78.5	31	

BOILER SHOP.

H. P.		
100	1	16-ft. gap hyd. fixed rivetter, pump, accumulator and crane complete.
	1	portable pneumatic rivetter for tanks.
	1	portable hyd. or pneumatic rivetter for mud rings.
10	1	heavy boiler plate punch or shear, 48 inches throat depth.
7.5	1	heavy boiler plate punch or shear, 30 inches throat depth.
5	1	tank plate punch, 30 inches throat depth.
5	1	tank plate shear, 24 inches throat depth.
7.5	1	boiler plate shear, 30 inches throat depth, ¾-inch plate.
5	1	flange punch.
	1	set flanging clamps.
35	1	12-ft. boiler rolls for ¾-inch plate.
	1	light 6-ft. rolls.
2	1	48 plain radial drill press.
2		30-inch vertical drill press.
	1	flange forge.
3	1	plate planer, 20-ft.
182	16	

FLUE SHOP.

H. P.		
15	1	Flue rattler.
5	1	cutting-off machine.
	1	flue-welding machine.
	1	flue-testing machine.
	1	flue-welding furnace.
2	1	emery grinder, 12-inch wheel.
22	6	

SMITH SHOP.

H. P.	
	1 6,000-lb. steam hammer, double frame, with crane and furnace.
	1 1,600-lb. long stroke, single frame steam hammer, for framework.
	2 1,200-lb. single frame steam hammers.
	1 600-lb. single frame steam hammer, for tool dept.
5	1 quick-acting belt hammer.
3	1 3-inch bolt heading and upsetting machine.
3	1 1½-inch bolt heading and upsetting machine.
7½	1 heavy shear to cut 4 by 4 inch bar.
5	1 shear to cut up to 5 by 1 inch.
5	1 shear to cut up to 1¼-inch round iron.
5	1 No. 3 Newton cold saw cutting-off machine.
	4 large open forges with cranes for framework, etc.
	6 forges with light cranes for medium work.
	10 forges with no cranes, for medium work.
	6 forges for light work.
	2 forges for toolwork.
	2 forges for springwork.
	1 furnace for springwork.
	1 hydraulic spring banding machine.
	1 pair eccentric rolls for spring plates.
	1 furnace for 3-inch bolt header.
	1 furnace for 1½-inch bolt header.
33.5	

WOODWORKING SHOP.

5	1 patternmaker lathe.
3	1 bandsaw.
5	1 medium-sized saw bench, crosscut and rip saw.
5	1 medium-sized hand planing and jointing machine.
18	

BOLT CUTTING, NUT TAPPING, ETC.

H. P.	
2	1 2½-inch single head bolt cutter.
4	1 1½-inch double head bolt cutter.
3	1 5-spindle nut-tapping machine.
3	1 bolt-pointing machine.
3	1 nut-facing machine.
3	1 special machine for cutting stay bolts.
2	2 special lathes for turning and threading stay bolts (crown).
5	2 double spindle center drilling and countersinking machines.
2	1 hacksaw cutting-off machine.
2	1 special driving box shell turning and box boring machine.
	1 pneumatic or hydraulic press for rod bushings.

	1	Arbor press, small (air brake dept.).
	1	Arbor press, small (brass room).
	1	Arbor press, large (machine or lathe dept.).
36		

TOOLROOM.

2	1	Eng. lathe, 20-inch swing, 10-ft. bed, taper attachment.
2	1	Eng. lathe, 18-inch swing, 8-ft. bed, taper attachment.
2	1	Eng. lathe, 16-inch swing, 8-ft. bed, taper attachment.
2	1	26-inch upright drill press.
.5	1	sensitive drill.
8.5	5	

H. P.		
5	1	24 by 24 inch by 6 ft. bed planer.
1	1	Universal milling machine, same as No. 3 Brown & Sharpe.
2	1	Universal grinding machine, same as No. 2 Brown & Sharpe.
5	1	Universal cutter and reamer grinder, same as No.3 B. & S.
3	1	Sellers or Gisholt tool grinder.
2	1	twist drill grinder.
1	1	small Arbor press.
1	1	power hacksaw cutting-off machine.
1	1	small plain emery wheel tool grinder, No. 1 Brown & Sharpe.
21	9	

Aggregate H. P. of all tools as above, 721.5.

ELECTRIC EQUIPMENT.

While the question of the individual location and arrangement of the tools has received careful attention, and we had at first contemplated showing this on an enlarged ground plan, we finally concluded to omit it, as such an arrangement is more or less determined by local conditions and circumstances.

ethod of plication termined by al nditions.

At the present state of the art, keeping in mind rational and economical conditions, also being governed by conservative, rather than radical considerations, we would advise a judicious combination of group and individual drives.

Generally speaking, tools requiring more than five horse-power should be provided with individual motors, although there is no hard and fast rule for this, as the location of the tool with more or less direct reference to the work performed, average running period, whether work is constant or intermittent, and how much variable speed is a factor, are the governing features.

It is the writer's practice to make a careful study of each individual

case, determine the space and distance to be covered, and arrange what seems best under the circumstances.

In numerous cases the work through the shop has been studied by means of templates of the governing sizes and pieces, drawn to scale, and these, worked over the plans, keeping in mind various combinations, exceptions and alternatives, have been of great assistance in determining the best location and grouping of the tools.

Such grouping and arrangement has been the basis upon which the motor selection, type of drive or the method of applying same, has been determined.

POWER HOUSE.

The equipment of the power house to completely cover the scope of the foregoing plans, necessary power for tools, steam for smith shop and heating, etc., is as follows:

Boilers. Two 400-H.-P. and one 200-H.-P. boilers, making a total of 1,000 H.-P. Ordinarily the two 400-H.-P. units will drive the shop and the third unit can be used as a spare.

The light or summer load can be handled by one of the 400-H.-P. units.

Air compressor. An air compressor capable of compressing 1,000 cubic feet of free air per minute.

Generators. One 200 K.-W. generator coupled directly to a 300-H.-P. cross-compound engine.

One 150 K.-W. generator coupled directly to a 225-H.-P. tandem compound engine.

Lighting. One 75 K.-W. generator coupled directly to a 125-H.-P. tandem compound engine.

This latter unit, besides taking care of the lighting, will handle sufficient power load to carry such departments as require to work overtime when the balance of the shop is shut down.

RECAPITULATION.

Boilers.

2 400-H.-P. units	800-H.-P.
1 200-H.-P. units	200-H.-P.
Total	1,000-H.-P.

Generators and engines.

1 200 K.-W. to 300-H.-P. engine.
1 150 K.-W. to 225-H.-P. engine.
1 75 K.-W. to 125-H.-P. engine.

650-H.-P.

Switchboard. Suitable switchboard to be provided.

Pumps and appurtenances. Ample capacity of boiler feed and fire pumps to be provided, also feedwater heaters and economizers.

Tunnels. Power tunnels are shown leading from power house to machine and

smith shop to carry all steam, water and air pipes and provision for all electric cables and feed wires.

echanical aft.

The absolute command of draft for the generation of the required quantity of steam, utilization of heat from flue gases made by improved forms of economizers, the ease of making ample provisions for large future capacity, and the low first cost of installation, as compared with the chimney, will commend the mechanical induced draft system in the construction of the modern power plant. With mechanical draft the labor of the fireman is much reduced, a cooler fire-room possible, with steadier steam and less labor in handling fires.

HEATING.

The heating of the machine and erecting shop, storehouse and office building to be by means of exhaust steam to stacks or coils, and the heated air circulated by means of fan blowers.

The various fan loads are as follows:

Machine shop, 4 25-H.-P. motors		100-H.-P.
Wood shop		10-H.-P.
Storehouse and office 2-10		20-H.-P.
Total for heating		130-H.-P.
Blowers for smith shop	25-H.-P.	
Exhaust fan for smith shop	25-H.-P.	
Exhaust fan for wood shop	10-H.-P.	
	60-H.-P.	60-H.-P.
Total fan load		190-H.-P.

LAVATORY AND SANITARY APPOINTMENTS.

enerous but ot ... xtravagant.

The needs of the employes in this regard should be generously but not prodigally given. The apparatus represented by the following illustrations, Figs. 7, 8 and 9, are at once attractive and substantial, but not extravagant. The apparatus is specially designed by the J. L. Mott Iron Works to meet all of the foregoing conditions, and comply with the best known and latest sanitary engineering.

ocation of ockers.

The men's lockers are arranged around the sides of and adjacent to the lavatory room. I prefer this arrangement to the plan of grouping the lockers about the shops adjacent to the workmen, for two reasons: First, because the men's belongings can be kept cleaner for the reason that they are not in contact with the dust flying about the shop, and second, if the men go to the lavatory room for their clothes the presence of washing facilities may induce them to use them.

Fig. 7 is a reproduction from a photograph of the lavatory in use at the Norwalk Iron Works.

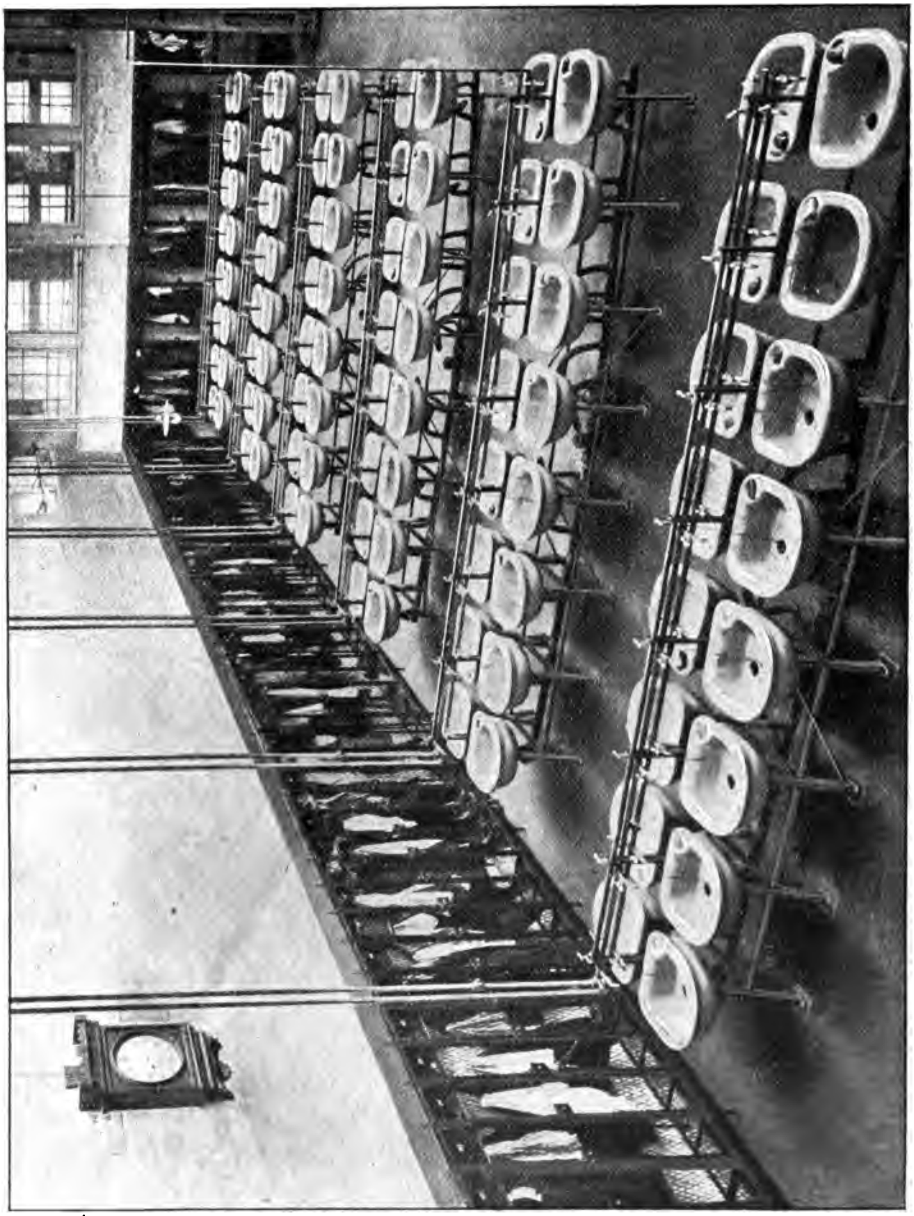
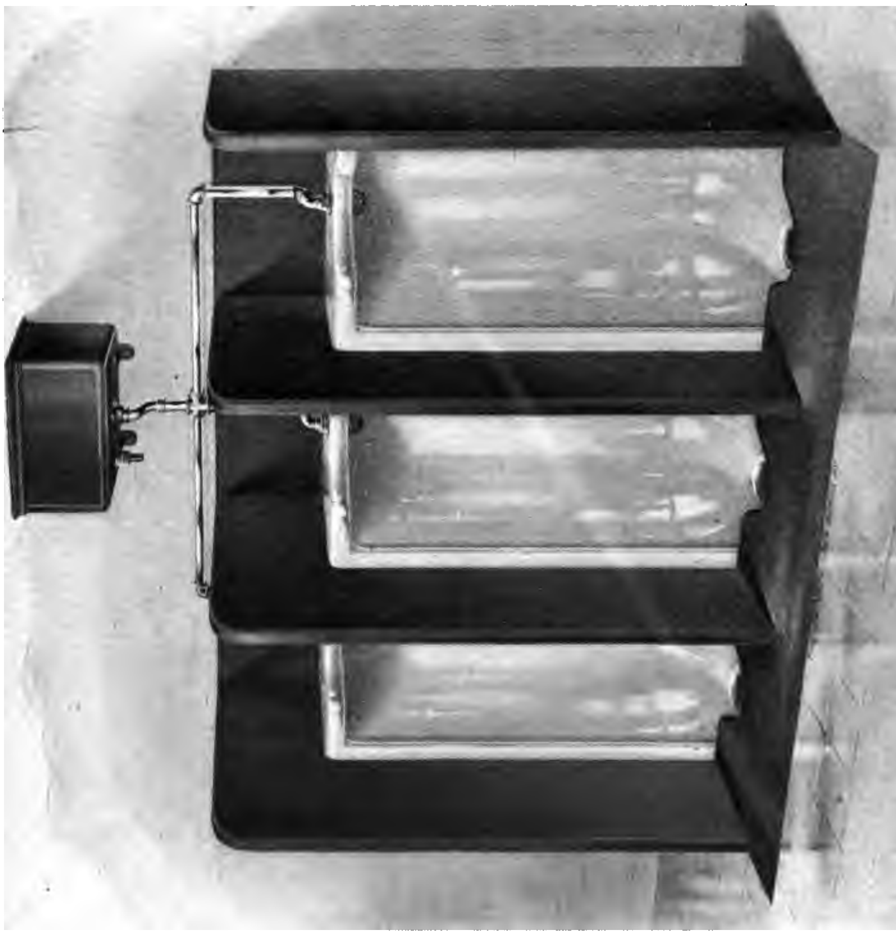


Fig. 7.



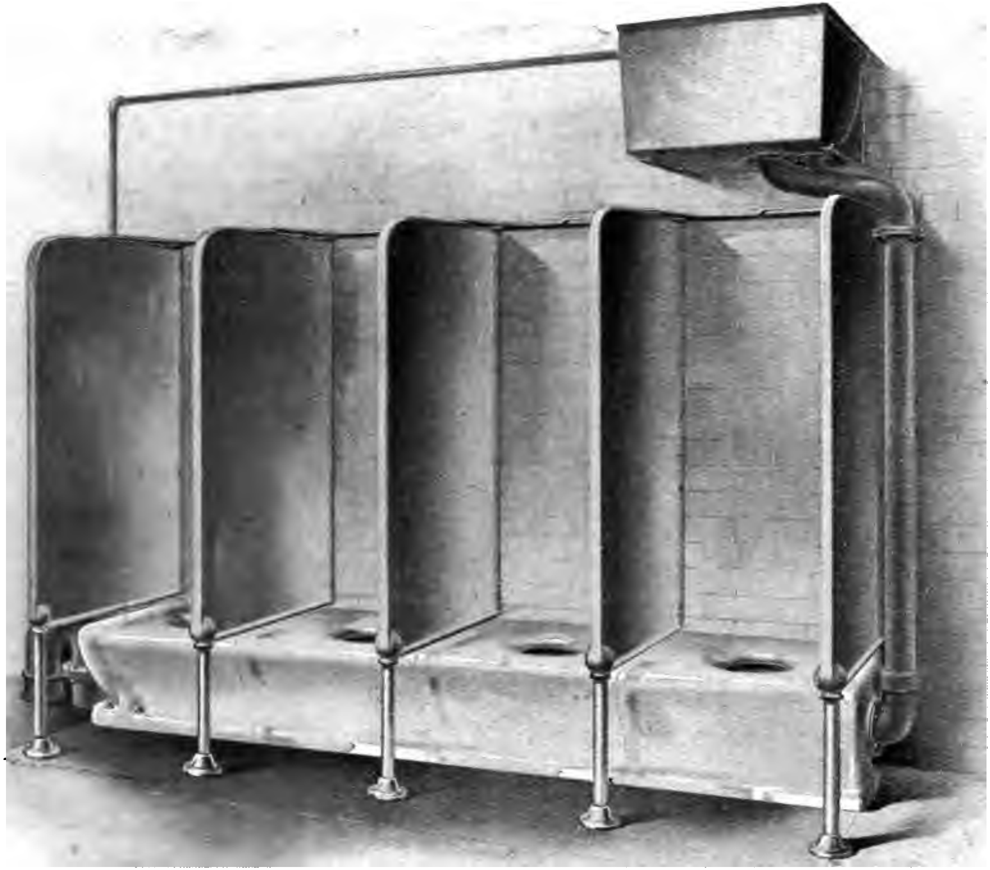


FIG. 9.—"SANITO" COLONIAL WATER-CLOSET.

COSTS.*

vantage of :urate cost :ping.

One of the most valuable fields of investigation for a shop foreman is that of cost of doing work on or by means of different machine tools, which are used in doing the work which he is required to supervise. One may say "that goes without saying," but in my experience, when you pin a foreman down as to the cost of different things you get very different replies. Some men, when you ask the cost of doing a certain piece of work — manufacturing, for instance, certain details of a locomotive — would give you the cost of the man's wages who runs the machine that manufactures this, taking the number of hours that he has to have the piece in the machine; another man will add to that the cost of the material that goes to make up the piece, but this is by no means the total cost of the manufactured part; in fact, it in general is rather a small percentage of the total cost. I recently had some investigations of this sort made in one of our shops, and I was rather surprised to find how much of the actual cost of manufacturing a certain article or doing a certain job of repair work was in the cost of moving the materials and appliances which are used to enable the man to do the job, and putting them away, in the grinding of tools, and of the incidental time that is taken up in manufacture. I had and am having this looked up in different shops, and as an example of what is being done in this direction, I will cite a case of boring cylinders, which is familiar to all railroad men. I have in my hand the statement of cost of boring cylinders of certain engines. I will simply read the data of the cost of this, with a view of showing the method which should be employed in arriving at the cost of doing this kind of work and of analyzing it, so that the different items of expense which enter into the total cost may be known and intelligent action taken upon them:

BORING CYLINDERS, ENGINE 298.

Right cylinder, before boring 16⅛ inches; after boring, 16¼ inches.
Left cylinder, before boring, 16⅛ inches; after boring, 16 9-32 inches.

	Hrs.	Mins.	Rate.	Amt.
Getting in boring bar........	0	30	$1.90	$0.095
Putting bar in cylinder......	0	45	1.90	.15
Putting up Flex. Shaft.......	1	0	1.90	.19
Rope broke and repaired.....	0	30	1.90	.095
Roughing in cut............	0	35	1.90	.11
Finishing cut...............	0	30	1.90	.095
Counterboring back end.....	0	30	1.90	.095
Counterboring front end.....	0	15	1.90	.05
Repairing and grinding tools.	0	30	1.90	.095
Changing bar..............	1	15	1.90	.24
Roughing cut...............	0	35	1.90	.11
Finishing cut...............	0	30	1.90	.095

* E. M. Herr, Proceedings W. R. R. Club.

	Hrs.	Mins.	Rate.	Amt.
Counterboring back	0	35	$1.90	$0.11
Counterboring front.........	0	15	1.90	.05
Taking down bar............	0	20	1.90	.06
Helper on job...............	3	35	1.90	.67
	12	10		$2.31

In order that ways and means for the reduction in cost of work may be intelligently effected, we must first determine what the work is actually costing under existing conditions; by being armed with this information we may argue from facts, and the force of our statements will be much greater.

Storehouse

The storehouse, besides serving the useful function involved in its name, can be made still more valuable as the basis of an adequate and comprehensive cost-keeping plan, by using it as the "clearing-house" of the system.

THE RAILWAY MASTER MECHANIC.

Specificati[on] for a maste[r] mechanic.

A successful master mechanic must be two-sided. He must not only keep the machinery under his charge in proper order, but he must discipline, direct and control the animated human machine that operates the inanimate tools or engines. He should therefore be a good mechanic as well as a good leader of men. He should be familiar with tools and should understand theoretically and practically the locomotive and other steam engines, as well as the laws of combustion. He can not ignore gas and petroleum motors. He should cultivate the habit of critically analyzing operating results shown in statements issued from his own and the accounting office. He should be a student of current technical literature. He should attend the meetings of technical societies, and under no circumstances should he fail to study their proceedings. He should cultivate a spirit of relentless self-criticism; should never be quite satisfied with what he has accomplished, and should determine to excel all others engaged in his particular line of work. To be a good leader of men, he should cultivate perfect patience, forbearance and self-control, remembering that no man ever controlled others who did not start by controlling himself. He should be even-tempered, or, if not born so, should not let any one discover it. He should be strictly just, granting cheerfully everything due his employes, while jealously guarding his employer's interests, curbing his generosity in spending funds intrusted to him. A man so qualified should make a successful master mechanic, but would not long remain one in the present day of keen competition in all branches of railroad service.—*J. Kruttschnitt, Pacific Coast Railway Club.*

ORGANIZATION.

Authority commensu[rate] with responsibil[ity]

"Considering first the matter of organization, it appears that the principle of having authority and discretion go with responsibility is the one above all others that is most important in obtaining the best results. It

would be understood, of course, that when authority is given an exact accounting should be required."

It is much easier to keep authority to one's self than to delegate it, but as responsibility can not all be assumed by one head, likewise authority must be delegated.

Again, the sublime importance of discipline, organization and the selection of subordinates, with direct reference to these qualifications, carries with it an obligation to refrain from meddling with their methods and willingness to abide by the results.

lope the tive.

There is also an implied obligation to give ample scope, for this tends to develop initiative, individuality and self-reliance.

ching rs should e vague.

Refrain from vagueness in giving a man his commission and instructions, or in delegating scope of operations and authority. Surely the men under him will not rate your representative higher than you do, consequently in every case magnify his office; in a word, provide such scope and authority as will put the man on his mettle, for only thus can the right kind of development be assured. Oftentimes the mere title selected, if appropriate, goes a great way in establishing a man's position at the outset, and helps to localize responsibility by designating clearly for what a man is accountable. It may be an incentive for record work, because a definite field of comparison is provided.

Also intelligently draw the line between comradeship and respect for superiors. Never be afraid of selecting a "bigger" man than yourself for a subordinate position, if you can get him, for one of the ways by which a man's executive capacity is measured is by the lieutenants he selects to carry out his policy.

rstudies.

"The selection of a suitable man for a position is a matter that is constantly arising, and often the right one does not appear at hand. Whenever this is the case, it is evidence that an important duty has been neglected. It is a clear indication that sufficient time and interest has not been devoted to the most important requirement. Men are prone to think of engines, shops and cars, and neglect men and organization. Think of having several, or even a thousand, men in a department and none at hand for a position. How much time and thought do we give to seeking out those who are susceptible of development, and of giving them opportunities and more responsibility to see how they will perform? Possibly one may feel that the pay-rolls will not stand such experiments, but it is clear that it is poor economy to be without enough good men to sustain an organization."

ot let the ideration e mate d out ghts of and ization.

economy without men to in an ization.

rtunity.

"A cheap executive is neither progressive nor economical. Having the right man for a position, he should be given every opportunity to progress. Every reasonable incentive or inducement should be held out to him to 'think' and to make his thoughts known. An opportunity to demonstrate, to some extent, some of the creations of his mind, is the food on which a thinking man lives."

premium e men's estions chemes etter ods.

led: matic ods for ing young

There is a crying need for more systematic methods of training young men for advancement. The great number of changes made during the

past two years in the motive power department of many large roads is impressive. It points forcibly to a serious weakness. Giving due weight to the occasional advantage of "new blood," these wholesale changes ought not to be necessary. Theoretically, every man should consider it a very important part of his work to educate and prepare his own successor. Subordinates should be secured with the view of the possibilities of advancement, and the most successful men of the future will be those who apply this broad and fundamental principle.

Educate and prepare your successor.

LABOR.

"Whether fighting or working, men are the same; they are assisted by good equipment, improved by good management, made more efficient by proper surroundings and comforts, and work more intelligently when properly trained. This is neither philanthropy nor socialism; it is business."

COMPENSATING LABOR.

The lowest form, and but one step removed from slavery, is the day's work plan.

Day or hour plan.

Any increase in effort by the workman redounds solely to the benefit of the employer, the workman having no share in the consequent increase of production, consequently there is no inducement offered for the man to exert himself.

Piece work.

On the contrary, a comprehensive piece-work system, administered fairly and intelligently, provides an incentive which makes it an object for a man to do his best, enlists his highest and best efforts both as to head and hands, and proves of great advantage because, by this means, the employer's advantage is in direct proportion to the incentive that appeals directly to the man's self-interest. The man's work ceases to be a task, and the employer a taskmaster, as the whole subject is treated on a coöperative plan.

Incentive enlists self-interest and coöperation

The so-called systems variously entitled "Taylor," "Bonus" and "Premium" plans are only modifications of the piece-work principle.

The premium plan.

The premium system, of which Mr. F. A. Halsey is the author, presents some very attractive modifications, and is described by the author as "A plan for paying for labor in which the gains, due to increased production by a workman, are divided between the workman and his employer."

General.

The piece-work plan, or any of the logical modifications thereof, established on a good basis, is highly beneficial to employers and employes, but the emphasis is on the "basis." Under such a system every workman feels that it depends largely upon himself how well he can succeed. He loses to a great extent that "don't-care;--I-am-doing-enough-for-the-pay-I-get" way, and goes in for all he is worth. Fundamentally, while "Practice may vary, Principles are eternal"; and consequently any objections to piece-work plans *per se* can not alter the principle, but mainly lie, and have to do with the practice or application of the principle.

If a man's compensation could be rated on a basis of tonnage output, and not on a per diem plan, the man's earnings would be computed on a more logical basis.

olute ness essary.

It must be ever borne in mind, in organizing any system of paying for labor, that all of the workmen combined, in any shop or department, are smarter than any one individual, be he foreman, superintendent or general manager, and that sharp practices of trying to take unfair advantage of the men in any way will react a hundredfold; absolute fairness is the first essential.

APPRENTICES — EDUCATION AND TRAINING THEREOF.

"A more perfect system of training will convert apprentice boys into more valuable workmen, and better workmen make possible a more efficient shop organization, and this should ultimately result in lowering the cost of the shop output. I believe that one way in which the cost of repairs can be reduced is by educating the apprentice. Whatever may be invested in the boy will, in proper time, through better work or more rapid working, appear as a credit in the expense accounts of the shops."

"There are marvelous possibilities of skill and invention among a class of boys who are never thought of as possible engineers — boys who sometimes make themselves leaders among the favored ones of the earth."

"I am fully persuaded that the engineering educational problem of the day and of the country lies in bringing of it within the reach of these. There is to-day an absolute famine of leadership talent in the shops of this country; while latent talent sufficient for all needs abounds, the only thing lacking being the means for developing that talent."

"At a meeting of managers some time ago, it was stated that two hundred young men, suitable for foremen for foundries, could be placed at once. Nothing is more difficult than to find men capable of filling such positions."

"The position of president, treasurer, salesman, etc., need not wait a day for applicants, but the man who is fitted to manage the practical details of a machine shop successfully is a rare man, and there is no scientific or professional man whose services are in surer demand than his."

"That system of education which tends to adapt the young man to any *institution* is bound to *fail;* the only successful education is that which will adapt the young man to his environment, and will train him to make the best use of himself under any circumstances."

"The great difficulty which confronts those who would find the right bearings and lead society toward a better state, is how to make out, not only what the final goal ought to be, but also the way to get there."

In bringing this paper to a close, I wish to place on record my obligations to Messrs. H. D. Gordon and S. T. Wellman, for valuable advice and assistance.

MR. POMEROY: I think a word of apology is due, perhaps, on account of the lateness of the reception of this report by the mem-

bers. The matter was finished some three months ago, and has been in type since the 9th of June, but owing to the failure to receive a drawing, from which a cut was to be made, the paper did not reach the convention until yesterday. The paper was originally worked out on several different lines, and afterwards one of these lines was selected as comprehending the purpose of the paper. There was no attempt to discuss details or to present any argument in defense of the various points chosen, simply an endeavor to touch on some of the fundamentals and suggested points. While, perhaps, we are quite agreed on fundamentals, there are wide differences of opinion as to the application of these fundamentals. You will readily concede, also, that some of the topics of the paper are of wide enough scope to require a separate paper. The idea was to make the paper as short as possible, and indicate some of the lines of discussion; and as mentioned in the preamble the paper is offered more in the line of suggestion than anything else, in the hope of bringing out some discussion to get at the facts.

THE PRESIDENT: Gentlemen, this very valuable and suggestive paper of Mr. Pomeroy is before you; what is your pleasure?

MR. QUEREAU: I move that the paper be received and opened for discussion.

The motion was carried.

THE PRESIDENT: This paper is before you for discussion.

MR. DAVID VAN ALSTINE: I cannot make a very strong criticism of Mr. Pomeroy's preferred arrangement of shop tracks shown at the top of page 3, because I have not had any experience with that kind of shop, but it appears to me that there is quite a heavy investment in cranes for the work to be done, and for the use that can be made of them. There are two 60-ton cranes in the erecting shop that will have between them one engine a day to handle. The only busy crane in the shop will be the 10-ton crane over the heavy tools.

I suppose the objection to the cross-track arrangement, with the transfer table, is that the transfer table is a bad feature in the winter and liable to fill up with snow and get out of order and the engines cannot be taken out. But I want to emphasize, particu-

larly, the value of a light high-speed crane for use over the erecting shop, because it is very valuable as a means of stripping engines, and putting the parts back on them, and in handling material. Such work cannot be done economically with a 60-ton crane which runs at 250 feet per minute.

On page 8, referring to steam and water pipes, I think it is mentioned later on that provision must be made to run the wire cables through the same tunnel with steam and water pipes, and I want to suggest that it is of vital importance that electric cables, if run in the same tunnel with steam pipes, must be thoroughly insulated, and I am not sure that they can be maintained even then on account of the heat.

On page 17, under "Heating," mention is made of motors required to run the fans, and I desire to call attention to the fact that it is considered by some that it is better to run the heating fans with steam engines, because when they run under light load the motors run at low efficiency. It does not make so much difference with the steam engine, because the exhaust steam is thrown into the heater and used for heating the air.

The subject of "Costs" is dealt with on page 21, and that seems to me to be a subject that has not had anywhere near enough attention; and I have thought for a long time that we make a mistake in keeping shop costs by the numbers of engines. It seems to me it does not cut much figure if engine No. 50 costs more to maintain than engine No. 51. If we find that there is a difference, we probably will not be able to find out what caused it, and it would not be of a great deal of interest to know it; but it would be of very great interest to have costs on parts of engines and in these costs to separate cost of labor and material. For instance, if we had a staybolt account, and we found that in the cost of the maintenance of staybolts seventy-five per cent of it was labor and twenty-five per cent material, then we know that labor is the part of that cost we want to reduce, if possible, and perhaps we can find some better way of putting in staybolts which we can introduce into the shop. Similarly, if we introduce a new tool for finishing driving boxes, the cost kept against driving boxes would quickly show whether the new tool or new method had brought about the desired results. The same statement would apply to the car work, boiler shop work, etc.

L. R. POMEROY (closing remarks communicated): Answering Mr. Van Alstine, the crane units selected were based on and planned to handle the heaviest prevailing type of locomotive, with a slight margin for any future increment in weight. In other words, to meet "up-to-date" requirements.

The provision for rapid auxiliary hoists and facility of one crane serving the boiler shop, when not engaged in lifting engines, perhaps would cover Mr. Van Alstine's point.

The arrangement of steam, water pipes and electric cables occupying the same tunnel applies more particularly to the main tunnel from the power house to the machine and erecting shops. In this case the cables should be lead-encased and run through vitrified conduits. It is taken for granted that all wiring and electric mains should be in accordance with the standard requirements of the local board of underwriters.

The question of heating fans run by steam engines rather than electric motors is well taken, yet I am constrained to say that there is no hard and fast rule for this, as local conditions would undoubtedly govern the selection of type of fan driving.

Mr. Van Alstine was mistaken in supposing that the 10-ton crane, running down the aisle, over the heavy tools, was to serve the riveting tower, because a separate crane is provided for the purpose of serving the riveting tower provided with two 15-ton trolleys. The 10-ton crane referred to is arranged to use in conjunction with the other cranes serving the boiler shop in handling parts of boilers, conveying material, etc., as the crane supports run the entire length of the building.

In concluding the discussion I wish to say a word relative to longitudinal versus transverse track arrangement. I had hoped that this feature of the paper would be fully discussed and bring out, if possible, real and tangible arguments in favor of transverse tracks. In this day of electric cranes and longitudinal tracks it is hard to see why locomotive repair shops with transverse tracks and transfer tables are not obsolete.

The transfer table and accompanying pit occupies valuable room, which can not be used for any other purpose. They make an ugly break in the communication between the shops, and render it difficult to cross by men and material. They can only serve the limited purpose of shifting engines sidewise from one track to

the Grant Locomotive Works, which it was proposed to build in Chicago. There is, however, some objection to the radial plan arrangement of shops, as there is much space wasted between them; so to meet that difficulty the plan was arranged as represented in the sketch marked Fig. 5. In that you will see there is a central turn-table and the shops are arranged about it in rectangular groups, and curved tracks are carried from the turn-table to the shops. That plan was not patented, and therefore, I am surprised that its merits have not been recognized up to this time. I think it has some very decided merits, from the fact that it makes every shop visible from the center, and makes every shop easily accessible from the central turn-table, and it places the office of the superintendent in a position where he has a view of all the shops.

MR. GEO. W. WEST: If I remember correctly, the turn-table at Frankfort is 100 feet, and it is necessary to put an engine behind the car or engine to be distributed to one of the shops. Our modern locomotives would require a turn-table still larger.

MR. FORNEY: I do not recall the size.

MR. WEST: The plan was to use a small engine to distribute the equipment to the different shops, either locomotives or cars.

THE PRESIDENT: Unfortunately, the hour of twelve has arrived. It seems unfortunate to break in upon this discussion, and especially so as Mr. Pomeroy, I understand, will be unable to be present to-morrow. I am going to suggest this, however, that we continue the discussion of this paper to-morrow morning, and those who have not carefully digested the paper may do so between now and 9.30 to-morrow morning; and we will ask Mr. Pomeroy, after reading a report of the discussion, to present in writing a closing discussion on the subject, so that it may be put in the Proceedings. There being nothing further, and in accordance with the vote made yesterday a motion to adjourn until 9.30 to-morrow will be in order. The train for the Locomotive Works at Schenectady leaves at 12.30 and returns at 4.30.

On motion, the Convention adjourned until the following day.

THIRD DAY'S PROCEEDINGS.

The Convention was called to order on Wednesday, June 25, at 9.30 a. m.

THE PRESIDENT: Before proceeding with the discussion of the report, rather the continuation of the discussion, the Secretary has communications to read, which will give us a few minutes more time until more of the members come in.

THE SECRETARY: At the first day's session, I stated that I thought I would be able to give the name of the candidate at Stevens' Institute who had completed the examination. I have a telegram this morning from the secretary of the institute that the results of the examination are not all in; so I am unable at this time to give the name of the scholar.

THE SECRETARY: The following resolution has been presented by Mr. Quereau:

Resolved, That in view of the close relations between the American Railway Master Mechanics' Association and the Master Car Builders' Association, both in its aims, influence, personnel, and place and time of meeting, and the very important influence of this Association on the safe and prompt movement of traffic, we suggest that a continuance of free transportation to and from our yearly conventions is worthy of careful consideration by the various passenger traffic associations; therefore,

Resolved, That the Executive Committee of the American Railway Master Mechanics' Association communicate with the passenger traffic associations and ask their consideration of our claims.

The resolution presented by Mr. Quereau was submitted to the vote of the Association and unanimously adopted.

THE PRESIDENT: Mr. Smith, are you ready to report?

MR. SMITH: Yes, sir. Your committee appointed to consider the recommendations in the President's address, begs to submit the following report:

First—We believe the president's recommendation that the ratio of weight on the drivers to the heating surface, as a basis of judging good practice in locomotive design, is well thought out, simple and worthy a committee to report at the next convention. We would therefore recommend that such a committee be appointed.

Second—The suggestion of the president as to extending the usefulness of the Association, by inaugurating tests and experiments affecting loco-

motive performance, to be carried on by trained experts under the direction, or supervision, of committees of this association and assisted financially from the funds of the association, is favored by this committee and we recommend it be carefully considered by the executive committee in mapping out the work for the coming year.

We believe the usefulness of the association in this direction would be materially increased, if its membership was placed on a representative basis, on lines similar to those of the Master Car Builders' Association, and recommend that the executive committee consider the matter and report on it at the next convention.

Third—The recommendation of the President as to the appointment of a committee on revision of the standards, recommended practice and standing resolution, is without question a good one, and we suggest to the executive committee that such a committee be appointed.

Fourth—In reference to the recommendation to appoint a standing committee to report to the association on "the progress of the year," embracing improvements in locomotives, shop practices, new machine tools, etc., it is thought there is a field for such a committee and we would recommend that it be appointed by the executive committee; that in the selection of this committee care be taken to include in its personnel members whose observations will cover the widest possible range, and who will bring new principles and methods before the Association for discussion.

Fifth—The suggestion of the President that more individual papers be presented is timely and is thought to be worthy of further extension. Your committee recommend that this suggestion be acted on by the executive committee.

R. D. Smith,
Peter H. Peck,
Wm. McIntosh.

On motion, the report was adopted.

The President: Gentlemen, we will now proceed with any further discussion of the paper that was presented by Mr. Pomeroy near the close of yesterday's session, "A Typical Shop to Serve a Road or Division Equipped with 300 Locomotives." The subject is before you for further remarks.

Mr. Seley: I move that further discussion of this matter be submitted in writing, and the subject be closed so far as verbal discussion at this meeting is concerned.

The motion was carried.

The President: I hope the gentlemen present and those that are not present, will present some further discussion in writing on this subject. It is worthy of careful consideration and worthy of

our expressing our views and exchanging views. Any communications of that kind that are received will also be sent by the Secretary, or a copy of them, to the author of the paper, so that he can make a general discussion of the subject as a closing part.

I might say with regard to the two subjects of topical discussion for yesterday's session, that neither of the gentlemen who were to open the discussion are present at this convention and neither of them have sent any communication with regard to it. They will be requested, however, by the Secretary, to make a written discussion of the topic and if so it will be published in the Proceedings.

The next report is on "Standard Specifications for Locomotive Driving and Truck Axles."

There are none of the committee on this subject present, so I will ask the Secretary to read the report, which is not very lengthy.

The Secretary read the following report:

REPORT OF COMMITTEE ON STANDARD SPECIFICATIONS FOR LOCOMOTIVE DRIVING AND TRUCK AXLES.

To the President and Members of the
American Railway Master Mechanics' Association:

Your committee selected to report on the subject of "Standard Specifications for Locomotive Driving and Truck Axles," when notified of their appointment, promptly organized for work, and in addition to sending out the usual circular, commenced a systematic canvass of the whole subject.

A few replies to the circular were received, mostly of a very comprehensive and interesting character. The information gathered was duly tabulated and arranged for a final meeting of the committee to determine upon the report to be presented. In this connection the valuable work of the International Association for Testing Materials, in formulating Standard Specifications for Axles and Steel Forgings, was brought to the attention of the committee, and it was thought that the proposed specifications, as drawn up by the American section of the International Association were in the main so comprehensive and satisfactory that, with slight modifications, they would be acceptable to the Association.

On this account it was decided to report progress and to ask the Association to authorize the committee, and invest them with the necessary power to coöperate with the International Bureau of Tests, with a view of having such changes incorporated in the proposed specifications as would make them acceptable to the Association, and to report to the next regular meeting of the Association.

Your committee would also request that a representative from each of the locomotive companies be added to the committee.

The importance of the subject and the changes desired are best described in the language of a communication addressed to the committee as follows:

"You will note that the International Association for Testing Material Specifications have attached a tabulated statement of the most prominent specifications in use, which will be of considerable use in formulating a set of specifications. These proposed specifications have been widely discussed in technical papers and societies during the last two years, and the forging specifications in particular will be discussed before the American Institute of Mining Engineers and the American Society of Mechanical Engineers at their spring meeting. This being the case, the Master Mechanics' Association would be doing a great service in the way of standardizing specifications if their committee would use the International Association specifications as a basis in framing their specifications.

"The specifications would require radical modifications before they would be acceptable to the Master Mechanics' Association. It is my opinion that the proposed specifications should cover:

"1. All locomotive forgings, axles, rods, pins and guides. It is at present the almost universal practice to use the same grade of steel in all these forgings, and there is no reason why there should be a different specification for these different forgings.

"2. The specifications should also cover blooms for these forgings, for the railroad company as well as the locomotive builder must protect themselves in the purchase of the blooms. In fact, in the case of railroads making their own forgings there will be no further tests required, for if the blooms are satisfactory the forgings, if properly treated, will also be.

"3. Because of the large size of many truck axles and the impracticability of making drop tests on them, it would be better to include locomotive and tender truck axles in a class with other locomotive forgings, and not in a class with car axles. This will prevent the use in locomotive truck axles of Bessemer steel, such as is now being used to a considerable extent in car axles.

"The International Association for Testing Material Specifications for steel axles are open to criticism because of the attempt to cover in one specification two classes of material, which in the matter of test requirements have absolutely nothing in common. This is the first time any attempt has been made to group car and other truck axles with driving axles, and in this respect makes a cumbersome specification, and an inconvenient one to use. The matter could be simplified very much by omitting all reference to driving axles in this specification, and covering the latter in another specification, specially drawn up for locomotive driving axles, rods, pins, guides, or by omitting drop-test requirement, and treat truck axles as other locomotive forgings.

"Their specifications for truck axles are representative of American practice, and fair to both parties of the contract, but the International

Association for Testing Material has disregarded the wishes of the great majority of railroad companies, as indicated by their present specifications in framing the specifications for forgings. They have subdivided the specifications for plates into three separate classes, namely: boiler plate, bridge material and building material; but their forging specification covers a multitude of grades and compels a purchaser to indicate in his contract the grade of steel he desires.

"There is less variation in the desires of the various railroad companies in the matter of steel forgings than in any other class of material, and the records of the International Association for Testing Material show that the users of this class of material who, more than any other, purchase their material to specifications. These facts should have been recognized by giving the users of this class of material a distinct specification for locomotive forgings. Such a specification should cover driving and truck axles, crank pins, rods and guides, and should be so explicit that there can be no question as to what is desired or what will be supplied."

Respectfully submitted,

A. E. MITCHELL, Chairman,
SAMUEL HIGGINS,
W. S. MORRIS,
L. R. POMEROY,
Committee.

W. MILWAUKEE, WIS., June 3, 1902.

On motion, the report was received and opened for discussion.

MR. GAINES: I agree with the committee remarks and think there is no question that the specification for driving axles should disregard car axles, and include engine truck axles, crank pins, rods, guides, and other locomotive forgings.

As to the specification itself and methods of testing, it would seem that the specification does not cover the matter entirely. The question of annealing is entirely disregarded, as well as that of oil tempering. Users of high grade steel are beginning to recognize the value of heat treatment after forging. Another point is the method of taking test specimens. Where a specimen is taken from one end of an axle or bloom only, the test is far from conclusive. I know of driving axles furnished by different manufacturers where one end of the axle would give normal wear while the other end wore so rapidly that it was worn below the limit before the opposite end had 1-16th inch wear. Upon etching sections of such axles, they show that one end has not been worked. Any specification for axles should be so framed as to cover this point.

Where driving axles are purchased in small lots, many roads may deem it extravagant when buying from 6 to 10 axles at a time to cut one up for test, and it is suggested that the specification should cover this condition also. It might be done by having an extension left on each end of one forging in a lot, or on all forgings, from which tests could be made. Or if this method is undesirable the axles could be used without testing, and in case of fracture or undue wear a test to be made in the regular manner. If the results show a material below the specification, the manufacturer to replace the forging. The latter would require the keeping of an accurate record of the manufacturer's heat number.

While I have referred to axles particularly, the suggestions would apply more or less to other forgings, although a forging of irregular shape or small section is more liable to be thoroughly worked. It might be desirable to specify a certain ratio between the cross section of billet and that of the forging in connection with a certain weight of hammer or a hydraulic press.

I think a modification of the international specifications is not only desirable but necessary, especially for a road in buying a small number of axles at one time.

MR. WEST: My understanding of Mr. Gaines' suggestion is that in case the axle is accepted, the company purchasing it will be expected to pay for the additional metal, and if rejected that the manufacturer will stand the loss.

MR. GAINES: Well, that could be done in two ways. You could have that piece left on the axle where you want to do your own testing in your own laboratory. Then the buyer would have to stand the cost. In other cases the extra piece could be tested in the manufacturer's shop and the scrap would be a loss to the manufacturer where they could not utilize it. That would be two ways of looking at the question and it is for the committee themselves to decide which would be the better.

MR. WHYTE: I do not see the necessity of considering tender axles as locomotive forgings. They are very properly car axles because most of the roads are using standard car axles under tenders; therefore I should think tender axles should be treated as car axles.

THE PRESIDENT: It will be noticed that the committee recom-

mend that the subject be continued and that a representative from each of the locomotive companies be added to the committee another year.

MR. P. H. PECK: I was going to suggest that the recommendation of the committee be adopted as far as reporting progress, and being continued, in addition to the representatives of the locomotive companies being added. I think it is a good idea. I move that it be adopted.

The motion was carried.

MR. WHYTE: I make a further motion that they be given the necessary authority to coöperate with the International Bureau of Tests.

Mr. Whyte's motion was carried.

THE PRESIDENT: The next report is on "Internal Combustion Engines in Railroad Service."

THE SECRETARY: Mr. Sanderson, chairman of that committee, writes me as follows: "I see my finish now with regard to the report on 'Internal Combustion Engines.' I have gathered some information together on the subject, but taking hold of new position here and the work involved in this is so heavy and keeps me away so much that I simply have not been able to do a thing at it. It is going to be reasonably certain that I will not be able to do anything in the matter in time for the convention this year. I therefore would suggest that you give the committee another year's time, as I really would very much like to work up this report during, as I hope, the slack months of the summer."

MR. PECK: I move that the committee be granted further time, and to report at the next convention.

The motion was carried.

THE PRESIDENT: The next report is an individual paper on "Helping Engines and Their Performances," to be presented by Mr. Gaines.

MR. GAINES: This is a pretty hard subject to cover in an individual paper, or any other, as it goes into a large territory not only of motive power, but of transportation, and by way of apology to the convention, I wish to state that I had in mind when I accepted this paper, the gathering of certain data, which I was not able to

obtain at the very last minute. I have tried to give a few principles in connection with helping engines, and also some things in connection with design, which it might be well to look over.

Mr. Gaines read the following paper:

HELPING ENGINES.

BY F. F. GAINES, M. E., L. V. R. R.
(A member of the Association.)

To the President and Members of the
American Railway Master Mechanics' Association:

The economy of using a helper under any given condition is determined by the total cost of transportation with and without the helper, of one ton, or some multiple of this unit, over the division. The conditions may be such as to require no calculation to demonstrate their economy. Or again, they may be such that only a very careful analysis of all conditions and factors is necessary to determine, whether or no, their use will be advantageous.

The leading factors in such a problem are: the volume of traffic; ruling grades, their length and rise; the time in which the traffic must be moved, due to competing lines; and the economical train length and tonnage considered in connection with other divisions. The combinations of the variations of these factors furnish an almost infinite number of conditions. Each condition requires separate study and treatment, and excludes from consideration any general law applicable to all. The economy of using a helper, and its tractive power, if desirable to use one, is generally indicated by the average volume of traffic.

Each of the leading factors are subject to many modifications in connection with varying profiles. A few of the more common grade conditions are:

1. A comparatively level division, with the exception of a ruling grade of comparatively short length.

2. An undulating division with heavy grades, and ruling grade only slightly in excess.

3. An undulating division with a comparatively short, heavy, ruling grade.

4. A division with a ruling grade of great length.

Assuming that the above conditions obtain in the direction of greatest volume of traffic, it is obvious that we may have the same or entirely different conditions of grade in the opposite directions. One of two conditions, as regards the size of train, may exist in a general way. In connection with other divisions it may be desirable to have trains of a certain tonnage, for reasons that will be dealt with later; or, for various reasons, the largest train that can be handled by one engine is much less than can be handled satisfactorily by one train crew. Some of the conditions that might result in the latter are: Average size of recently built power, owned;

limiting weight of engines, due to bridges, rail, tunnel and other clearances; or a standard road engine of insufficient power on the heavy grades. Where the economical tonnage, as regards handling by the train crew, or a standard train can not be handled by the leading engine under the four general grade conditions, it would seem from a theoretical standpoint to call for a helping engine or engines.

The general conditions referred to divide into two general sub-classes: First, where the length of grade is such that the helping engines are required only for a part of the division, and, second, where the helping engines are required for the whole division, or the greatest part of it. Cases 1 and 3 come under the first subdivision, and cases 2 and 4 under the second. Under some circumstances case 3 may come under both; that is, double heading over the division, with a helper in addition on the heavy grade.

Where a helper is used only for a part of a division, and the helper is of the same power as the road engine, the tonnage handled over the division is doubled per train; the cost per ton-mile for fuel, wages of engineers and firemen, etc., is lessened in some cases; while the wages of one train crew have been saved in one direction, and if the road engines can handle the tonnage in the opposite direction alone, the wages of a train crew over a division and return have been saved. The light mileage of the helper is offset by the underloading of the two road engines that are necessary to handle the same tonnage without a helper, after passing over the ruling grade.

Where double heading in one or both directions over a division, with leader and helper of the same power, the wages of the second train crew are saved. Where the return tonnage can be handled by the leading engines, there is an additional economy due to the difference in expense of the light mileage of helper, and the underloaded second engine that would otherwise be necessary.

In general, where a helper, either over a division or part of it, of equal or greater power than the leader, can be used in connection with normal loading, the economy is real and substantial. As the proportion of power to be furnished by a helper decreases, a point is reached where the economy curve changes direction and becomes negative.

There are certain conditions where the volume of traffic is light, and a certain number of trains are to be run irrespective of their size, which make it more economical to have engines of sufficient power to handle the necessary trains under the grade conditions.

When the volume of traffic becomes so great that to handle the trains requires a more powerful engine than can be run, owing to the physical limitations of the right of way, from a theoretical standpoint a pusher or double heading becomes desirable.

On a trunk line, handling a large volume of through freight between its termini, it would seem that the maximum train that could be handled on the level, the limitations being due to length of train that can be handled

with safety, should be its standard train. The size of the standard train may be further limited by the speed, as in fast freights, the lengths of sidings or physical limitations of the right of way, such as bridges, rail, ballast, etc., prohibiting the use of a sufficiently powerful engine. Whatever the limiting factors, a standard train becomes desirable. With it yard work, delays and wear and tear due to shifting are eliminated at each division terminal it must pass from origin to destination. It will readily be seen that the time saved, where a train is brought in by one crew to a division terminal, and immediately taken out by another without shifting, is considerable. The expense of maintenance is also considerably decreased by such an arrangement, as it is safe to say that out of the total cost of repairs to rolling stock more than fifty per cent of the cause is due to shifting in yards. Under a standard train system it is desirable to have the leading engine of sufficient power to handle the train at the desired speed over the level, or comparatively level, divisions. The power of helping engines on the grades may then vary from a very small to a very large engine. Where no such system is in vogue, and each division handles its traffic to best advantage, independent of the size of train that may be delivered to it, or that it may turn over, the problem is simplified, in that it depends solely on the profiles of the different divisions, and each division can be treated separately.

From the record of a six months' performance of a number of engines of the same class, on the Wilkesbarre mountain grade of the Wyoming Division of the L. V. R. R., the percentage of cost of the more important items, constituting the total direct cost per ton-mile, was found to be as follows:

	Per cent.
Water supply	0.346
Waste and other supplies	1.167
All oils (lubricating and illuminating)	1.259
Roundhouse men (hostlers, wipers, etc.)	2.478
Interest and depreciation	12.315
Repairs	16.188
Fuel	16.366
Wages of engineers and firemen	21.386
Wages of train crew (exclusive of engine crew)	28.495
Total	100.000

It is apparent that with another engine of the same class as helper the tonnage would be doubled, the cost per ton-mile of all items remaining the same, with the exception of the wages of train crew, which would be decreased fifty per cent. As the cost of this item per ton-mile would be reduced by fifty per cent, and as it is about twenty-eight per cent of the total cost, the saving would be fourteen per cent on the double tonnage, or twenty-eight per cent. It is also evident that an engine of less power would effect a less saving, and one of greater power a greater saving.

These figures would vary under different conditions, but they indicate approximately the proportions of the different items constituting the total direct cost, and show that the direct economy is largely due to cutting down the cost of wages of train crew per ton-mile. There is also an indeterminate saving, where helpers are used, due to the fewer number of trains. Where the volume of traffic is great, and must be handled on a single track, or at least two tracks, in connection with a number of passenger trains, the indirect saving is no inconsiderable item. In some cases, a large volume of traffic may originate at, or near, the foot of a heavy grade; under these conditions it is sometimes advisable to make up the trains at the summit, and handle the tonnage on the grade entirely by helpers, or all except the amount in some cases handled by the road engine when on the way to the summit to take out a train. Obviously the more powerful the helpers the greater the economy until the limiting size of engine is reached.

There are three leading factors which largely determine the limiting size:

1. Weight that can be carried by rail and bridges.
2. Clearances, such as overhead bridges, tunnels, etc.
3. Construction of rolling stock.

There is also a point reached where the coal consumption per hour becomes so great that one or more additional firemen are necessary. Until such time as all cars have very much stronger underframes and draft gear than the average car of the present day an engine with a tractive power of about fifty thousand pounds would seem to be near the economical limit.

An ordinary road engine, unless specially designed for such service, should not be used as the second engine in double heading, as, in addition to its own power, the frames and draft gear have to transmit the power of the leading engine. Conversely, an engine that is to be used for double heading or pushing should be designed with the service intended for in view. As on heavy grades the maximum power is exerted at slow speeds, all parts should be extra strong, such as frames, rods, axles, crank pins, etc. The wearing parts should have liberal bearing surfaces, and provision for ample lubrication. Tenders of large coal and water capacity should be provided so as to cut out all or as many stops as possible on grade, as the time lost and damage to cars in starting is considerable. Where the grade is comparatively long it is doubtful economy to use a small diameter of driving wheel, on account of the greater power. It would seem a better policy to use a size of wheel that would allow the light engine to make good time down the grade without heating bearings, or shaking the machinery to pieces, and to provide for the necessary power in the steam pressure and the size of cylinders. The front drawhead should be as short as possible; the greater the overhang the greater the leverage tending to break or dislocate it. The breast beam should be heavy, and preferably of wood, so as to cushion the drawbar shocks. The use of a

heavy plate back of the breast beam sometimes saves a broken cylinder in case of collision. The pilot should be short enough to clear outside hung brake beams on freight cars. The guides, especially on four-cylinder compounds, should be tied near the center to prevent springing.

The yoke waist sheets should come well out toward the end of guides and be well secured to the boiler. If the waist sheet is in the center only, the frames must take care of the stress, frequently resulting in a fractured frame near the point of attachment. The connection between engine and tender should be flexible, with a spring buffer to absorb shocks. The deck plate or tail bars should be heavy and well secured to frames. The connecting rods should be extra strong, and the main connection on side rods keyed, so as to take up lost motion and prevent pounding. The tender drawbar should be of M. C. B. type, in connection with a friction draft rigging. As the water evaporation is heavy, a good inlet from tank to injector should be provided. A majority of the manufacturers prefer the following sizes of feed pipe in connection with the different-sized injectors:

No. 8, not less than 2 inches internal diameter.

Nos. 9 and 10, not less than 2½ inches internal diameter.

Nos. 11 and 12, not less than 3 inches internal diameter.

The clear opening of strainers and tank valves should be the same area as the pipes, while the hose should be ½ inch larger, to provide for decreases due to bends, etc.

Tenders of large size should have the front of sides cut down, where it is not practicable to raise the floor, so as to admit air in summer. The manholes should be large so as to make accurate water stops unnecessary. The underframe should be of heavy steel channels or eyebeams. The trucks should have a spring arrangement that will insure steady and smooth riding under either a full or empty tender.

No class of service makes heavier demands on power than helping service, and time spent in careful design so as to produce satisfactory results will be amply repaid by the decreased maintenance charge. In designing, special care should be given to accessibility, both on the road and in repairs. Helping engines are frequently located where they can only receive roundhouse repairs between general overhaulings, so that the desirability of a design to which running repairs can be made cheaply and quickly is very essential.

THE PRESIDENT: Mr. Gaines' paper is before you. What is your pleasure with regard to it?

MR. DAVID BROWN: I move that it be received and opened for discussion.

The motion was carried.

THE PRESIDENT: The paper is before you for discussion.

MR. C. H. QUEREAU: A gentleman near me says, "Go it, goat," and I guess I will. A red flag is sometimes of service in starting up discussion. While I agree in a great many more points with the paper than I disagree, I think possibly it would be more valuable to call attention to some of the facts on which I disagree, or rather, a number of the facts which apparently have not been taken into consideration in preparing the paper.

So far as appears from the paper only the advantages of double-heading have been called to your attention, and it is double-heading as usually understood rather than pusher engines or helper engines that I am now discussing. As it occurs to me, so far as the paper is concerned, only the credit side of double-heading is mentioned. There is also a debit side, and the debit is frequently very high;—under certain conditions so high as to make it very doubtful if double-heading pays. I have in mind a road which undertook to double-head as an economic transportation proposition, but the practice was abandoned after a comparatively short time and the reasons will appear from what will follow. A very large proportion of the freight cars are built for locomotives having a tractive power of from twenty to thirty thousand pounds. Those cars are still in service, and when a locomotive of from thirty to forty thousand pounds tractive power is used, or when two locomotives having a combined tractive power of seventy thousand pounds are used, it is very easy to see that there are very large chances of considerable damage being done to the cars. The chief reason for abandoning double-heading on the road that I mentioned, was the excessive number of cases of break-in-twos and damage to draft rigging—not only the immediate damages from the breaking in two, but the consequential damages throughout the train.

It happened six or eight months ago that I was in charge of a road test of locomotives. The locomotives were of large size and the trains long and heavy. There were a number of break-in-twos during this test—over 75 per cent of which I believe could be charged justly to the large size of the locomotives, and in the majority of those break-in-twos the train was separated at more than one point. The delays were numerous. When we have all steel cars or steel center sill cars, with the friction draft rigging or strengthened draft rigging, the matter of double-heading will

assume quite a different aspect, but we must for the present consider it under present conditions.

Another objection to double-heading is the long delays in getting over the road, involving lying at side-tracks, additional fuel expense, and that of additional expenses on account of overtime. I have in mind a district 95 miles long where double-heading trains frequently required from 21 to 26 hours to pass over it. To be sure, this was in a time of very heavy traffic and when one considers that overtime usually begins at the expiration of ten hours' work for engine and train crews, it can readily be seen that there is a large debit to be placed in this double-heading account.

In this connection, I wish to suggest for consideration—there is no time to elaborate it—the thought that under such conditions as I have indicated, namely, heavy traffic, comparatively short trains and comparatively high speeds are more economical than long trains and double-heading. I think that is well worthy of investigation. During the test to which I refer, which was not during the season of heaviest traffic, we frequently laid on side tracks from half an hour to an hour and a half, simply because the train was so long and it took such a length of time to get it up to speed, that we could not go even to the next station. If we could have made the time from one station to another in anywhere from three to five minutes less time than the weight of the train made it necessary to take, we would have gone.

In considering this matter, I believe it would pay whoever has the decision in the case to spend two or three weeks out on the road, seeing just how trains are operated, just what delays there are, and I believe he will realize that there is a large debit in the account of double-heading.

Another debit which should not be overlooked is the fact that in cases of double-heading it requires at least twice the time, and usually more than twice the time, to take coal and water and clean the ash pans with two engines, as compared with one. Another matter which, although not so important, is worthy of consideration, is the matter of hot bearings. I believe an investigation will show, and the experience of those who have come in contact with double-head service will bear out the statement, that the number of cases of hot bearings and the length of delay in the case of double-heading, is much greater than where but a single engine

is used. This is particularly true if the speed is anything more than that of a maximum tonnage freight train, these hot bearings usually appearing upon the second locomotive. I know of a case where the practice of double-heading on passenger trains was very largely, although not entirely, abandoned because of the delay due to hot bearings on the second engine, because of the dust and dirt stirred up by the head engine.

Another feature not on the debit side, but one which I think is well worthy of consideration in connection with helping engines, is the design of the way cars or cabooses. You will all readily understand that if the caboose platforms are not of sufficient strength to withstand the power of the pusher engine, the way car is cut off and the pushing engine placed next to the train with the way car behind it. This I know is standard practice on a good many roads. It seems to me a very simple proposition to do as the Santa Fe is doing—leave off the end platforms, using a side door or, as some other roads are doing, extend the main sills of the car through the platform, making the frame continuous from one end to the other. There are a great many advantages in having platforms, and the use of the framing, including the platform, will make the way car as strong as any other car in the train.

A matter called attention to by Mr. Gaines, which I think well worth emphasizing in commendation, is the matter of the diameter of the driving wheels for engines to be used not only as pushers on grades, but applicable to all power to be used on railroads having unusual grades. I am thoroughly satisfied that the point he has made is a good one, and that it will work out to advantage in practice, namely, that the driving wheels for railroads situated as those I have indicated, should be larger than the usual practice is. I call to mind now one road on which the outside diameter of the driving wheels, until a comparatively few years ago, was 48 inches. This engine gave excellent service in going up hill, but in getting from one end of a division to the other, to use a slang expression, "they were not in it" with locomotives having larger drivers. The consequence was that a two-inch tire was left on the wheel center and made a part of the wheel center and the tire placed outside of that, increasing the diameters of the drivers four inches. About two years ago, the driving wheels of a standard freight locomotive were increased from 48

up to 55 inches—that includes the tire—with very good results. The power of the locomotive which was taken away by increasing the diameter of the drivers, was made up by a larger cylinder and increased steam pressure.

In the report you will find the sentence: "As the water evaporation is heavy, a good inlet from tank to injector should be provided." I do not wish to be understood as advocating, by any means, a small inlet or a small passage for the water, but the reason given here, it appears to me, is not a good one, or rather is not particularly applicable to these conclusions, because the high duty in evaporation occurs not at slow speeds, but at high speeds. It is our passenger and fast freight locomotives on which the injector fails to supply the water, because at high speed a greater amount of steam is demanded in a given length of time, although the total amount of steam used per revolution is considerably less.

MR. WEST: I did not understand Mr. Gaines' paper to be on double-header engines. There are roads, and especially Mr. Gaines' road and the road which I represent, that are located in a district that makes it necessary to use helping engines. We are not troubled with long trains. It requires three 100-ton engines to move 50 cars over our grades. It is to cover these points that I understand Mr. Gaines' paper was taken up and made ready for us, and I quite agree with Mr. Gaines' recommendations, and I disagree with Mr. Quereau with regard to water evaporation. I think if he followed some of the 100-ton engines up our heavy grades, he will find they get away with water as fast as any passenger engine.

MR. DAVID BROWN: The gentleman has just given his report as he feels—in other words, he has given his report to conform with the circumstances he has to contend with. No doubt Mr. Quereau is also right under the circumstances he has to contend with; but where we have a mountain to get the cars up, and when they get on top that engine has to proceed with the double-head train, it is necessary for it to get assistance up the hill. That is conceded, and the circumstances he has described are very good for that kind of an engine. On the hill generally the helper is behind. In that case the cars have not got the strain on them to pull out the draw-heads that they would if both were ahead.

Consequently that is obviated. But where you have to go any distance beyond the hill with the helper, I am not in favor of the helping engine being either ahead or behind. On the road that I am connected with, we have a very serious problem to contend with on a certain part. We start out of Scranton and it will take four engines to take a train eight miles up the road that one can take from a point 48 miles up the road, and it will take two engines to take it from the eight-mile point to the 48-mile point. Under those circumstances something has to be done for assistance, and it takes as I say four engines to take it the first eight miles, and then it will take two, and at the 48-mile point it will take one engine only.

Now, what are the best measures to adopt in that case? I claim that after you get the cars up the first eight miles where you require the two engines on the train for the other forty miles, I say it is not right to have them both ahead, nor is it right to have one behind. If you have them ahead you are liable to pull out your draw-heads or your end sills. If you have them behind you may go along for awhile, and the first thing you know something will happen to derail a car and you may shove it over on the other track or down an embankment on the other side. But I do believe when they get up to the eight-mile point, if the train was so arranged that one engine would be ahead and the other about forty cars back—this would leave about forty cars for the second engine —and if the first engine had control of the air brakes of the cars between that and the second engine it would control the train for what grades we had to descend or any ordinary stops. The second engine, if that was connected up with the brakes behind it, could be used for an emergency, or if anything happened to the other engine. I think that would be a safe way of handling a double-head train until they got to the forty-eight miles I have described, then take the second engine out and the one engine proceed, and the second engine would return in the same manner she proceeded, as there are grades on the return journey in some parts of it.

As to taking water, we have to make arrangements for that, too. We have certain points on the road where the engine would have to stop to take water, one point one way and another point the other. In that case I think a water crane could be put ahead

of the present tub, and as the engines approached the water station the first cars to be cut away from the second engine, and each engine would run up to its water pipe, one to the crane and the other to the tub, stop, cut loose, as is our practice, take water, go back and couple to the train, and proceed. Under these circumstances, I think little delay would follow taking water.

I think the report presented by Mr. Gaines is very good. There is nothing about it but what is perfectly proper to follow, and it takes an engine that can be relied on for such work. Furthermore, we look to a helping engine to do, if possible, the greater amount of work while assisting, to favor the other engine to proceed after it cuts loose.

PROF. HIBBARD: I am very glad to see that Mr. Gaines has incorporated in his paper so many excellent features on the design of helping engines, and it corroborates a very recent paper of his which appeared in the *American Engineer,* on the subject of why a railroad company should design its own locomotives. I would like to call attention, however, to the spring buffer connection between the engine and the tender. All engine-tender connections should have the spring buffer instead of the antiquated rigid rubbing iron and wedges. So far as I am acquainted with the locomotives on his road, the design used is all right; but, in looking over several that are on exhibition at this convention, I saw that in several of the locomotives—possibly in all of them—the spring buffers were very bad.

Two years ago I was talking with an English locomotive superintendent with regard to a certain feature of some designs over there, and I said: "It seems to me that design would not stand getting off the track." He replied: "We do not design locomotives to run off the track." I believe it is one of the features of American rolling stock that while we do not want them to get off the track, yet the rolling stock is so designed that if it does get off the track we can get it on again easily, quickly and with little damage, and the rolling stock can go on its way rejoicing. This spring buffer which is on the engines over on the exhibition track is bad, because if the engine or tender gets off the track and the spring buffer has a chance to slip past the corner of the rubbing plate, on the other portion of the tender or engine, it will get shot out by its powerful contained springs and get caught past that

corner. If you try to get the tender or engine on to the rails in line again, you are up against a bad proposition, something I have heard that the wrecking crews do not care much to tackle; but that difficulty may be easily obviated, simply by broadening out the rubbing iron and thinning it out to nothing at its edges or sides, so that there is no corner for the spring buffer to catch against and the engine and tender may be one foot, two feet or three feet out of line with each other, and still there is no corner for that spring buffer to catch over, and you can pull the engine and tender back on the track with comparative ease. It is a small correction in the design but it is said to make an amazing difference practically.

I have heard some remarks since I have been at the convention with regard to the spring buffer connection between the engine and tender as being, well, doubtful. The preceding may be one of the reasons why they look askance at that sort of connection. Another may be that they have difficulty in connecting the engine and tender draw-bar. One road, I remember, used to butt another engine against the tender to compress the spring enough to drop in the draw-bar pins. Another road with which I was connected had a bright shop foreman and he arranged a rather heavy bolt with a hook at one end and washer plate at the other, and a big nut and good-sized wrench. He would bring the engine and tender together, couple in this hook against the tail-bar of the engine, or vice versa, and nut and plate against the other portion of the combination, and then by means of a big wrench screw the two together so as to compress the spring buffer enough to drop the draw-bar pin into place.

MR. C. A. SELEY: In regard to the general proposition of coupling engines, or double-heading, it seems to be a matter of conditions. There are many roads in the United States in which double-heading is not proper, in my opinion. On the road with which I am now connected, its traffic is mainly fast freight and stock movement, and the cars run in a section of the country where fast double-heading results in hot bearings on the second engine. Consequently the practice is very much restricted and is confined to but a few points. On the contrary, there are numerous roads in the country where double-heading is extensively practiced, and where pushing engines are also an additional means of

getting trains over the road. In this connection I have in mind a point on the Norfolk & Western road where three-engine trains are the rule. The point as to location of way cars on these trains is an important one. When you put a 23 and 35x32 inch cylinder engine behind a way car, the boys get out on the coal, and it is sometimes the case that these four-wheel cars are lifted off the rails, particularly with the present vertical plane coupler.

I think the matter of double-heading should be decided by the transportation department, and while we can offer suggestions, I think in the main we should be glad to get the information in this paper to assist in designing a good and proper construction in engines which will undoubtedly be used in a great many sections of the country for double-header as well as pushing service.

MR. WHYTE: There are two or three things in the paper to which I will call attention. On page 5 the statement is made: "The yoke waist sheets should come well out toward the end of guides and be well secured to the boiler. If the waist sheet is in the center only, the frames must take care of the stress, frequently resulting in a fractured frame near the point of attachment." I would call attention to the importance of supporting on the frames the boiler and other parts located above the frames, so that, as nearly as possible, the support may be immediately above the middle connection of the equalizers. When this is not done the frames are frequently broken. Further down on the page the report says: "The manholes should be large so as to make accurate water stops unnecessary." These openings are generally longer in one direction than the other, and the longer direction being crosswise of the tender.

There is another thing about locomotives with large and small driving wheels. We can build locomotives with large driving wheels, having the same calculated tractive power as other locomotives with small driving wheels, yet the experience of the engine and the train crews is that locomotives with the large driving wheels are not as satisfactory on grades or heavy service as locomotives with small driving wheels. Our calculations show otherwise, but the experiences on the road do not quite confirm our conclusions.

MR. F. F. GAINES: I might make some comment on some of

the discussion. I do not wish to be understood that I am an advocate of the double-heading under any and all conditions, but I would like to bring out one condition where it seems to me it is justifiable to double-head. You have a piece of track where your bridges are light. Perhaps the bridges will not carry an engine weighing over 85,000 to 90,000 pounds on drivers. That is not unusual on some of the branch lines, and the branch lines at the same time may contribute a very heavy traffic. Two engines of 20,000 pounds tractive power would be only 40,000 pounds tractive power, and yet at the same time it would not be sufficient under numerous conditions. Under these conditions it is quite likely that double-heading may be advantageous.

Referring to the question of cabooses, I think there is no doubt that Mr. Quereau's remarks are in the right direction. We are building some cabooses at this time in our shops with a heavy steel under frame, running from the end sill to the end sill of the platform, practically making a continuous backbone right between the couplers.

In regard to the large tank and the water evaporation, roughly speaking we have engines which evaporate 7,000 gallons of water in a little over an hour, and I think that means pretty good water connections all the way through. They are in the pushing service, too.

Referring to Mr. Whyte's remarks on the manhole question, I noticed in a locomotive shop the other day a tender which had a manhole the complete width of the top of the tank. I do not see any objection to having a manhole as large as possible, if it is not in the way of anything.

In regard to large and small diameter of driving wheels, I am willing to admit that a large diameter of driving wheel, where you are exerting the utmost power, has more uniform rotative movement and is a little more powerful. On the other hand I think the wear and tear of the engine sufficiently offsets that to make it advisable to use a rather larger size of driving wheel. I would say I personally would not want a driving wheel under 50 inches, outside of the tire.

MR. ANGUS SINCLAIR: I move that the discussion be closed.

The motion was carried.

THE PRESIDENT: The next report is that of the committee on "Standard Pipe Unions." Mr. C. H. Quereau is the chairman of the committee.

Mr. Quereau read the following report:

REPORT OF THE COMMITTEE ON STANDARD PIPE UNIONS.

To the President and Members of the
American Railway Master Mechanics' Association:

It will probably be remembered that a committee was appointed by the American Railway Master Mechanics' Association, by the Master Car Builders' Association, and by the American Society of Mechanical Engineers, to report on Standard Square Head Bolts and Nuts, and Standards for Pipe Fittings; that the subject was divided, the matter of Standard Wrought Iron Pipe Threads being assigned to the committee of the American Railway Master Mechanics' Association, the matter of Standard Square Head Bolts and Nuts to the committee of the Master Car Builders' Association, and the matter of Standard Pipe Unions to the committee of the American Society of Mechanical Engineers, each committee to prepare its report independently, and to report, not only to the association appointing it, but to each of the other committees, and through them to the associations they represented.

The reports of the committee of the American Railway Master Mechanics' Association on Standard Wrought Iron Pipe Threads and of the committee of the Master Car Builders' Association on Standard Square Head Bolts and Nuts, have been made and adopted by both these associations. The report of the committee of the American Society of Mechanical Engineers on Standard Pipe Unions has been made to that association since last June and approved. The report is as follows:

To the American Society of Mechanical Engineers, New York, N. Y.:

GENTLEMEN,—Your committee, appointed to consider the subject of securing uniformity in the threads of coupling unions for pipe, in joint conference with similar committees of the American Railway Master Mechanics' Association, and the Master Car Builders' Association, beg leave to report as follows:

After considerable delay in getting the committee together, due first to the special engagements of some of the members in Government service on account of the war with Spain, your committee was finally organized with its present membership about two years ago and immediately took up the work assigned to it with the corresponding committees of the American Railway Master Mechanics' and Master Car Builders' Associations.

It was found that the committees of these Associations were also considering two other matters, namely, Uniform Pipe Threads, and Standard Square Heads for Bolts; and desired your committee to proceed with the active consideration of the subject of Uniformity in the Threads of Coupling Unions for Pipe.

A careful examination of the dimensions of the threads in the unions made by each of the principal manufacturers of these fittings showed that there was absolutely no two alike, and, further, that the other dimensions of the unions were so affected by the dimensions of the threads in the coupling nut that any successful attempt at uniformity in the threads must necessarily carry with it uniformity in so many of the other dimensions of the union itself that it would be necessary for this committee to take up not only the dimensions of the threads but of the entire coupling union.

A careful study of the design of all makes of unions, now commonly used, was then made for all sizes of pipe from ⅛ inch to 4 inches, inclusive. This investigation showed that no make of unions was sufficiently free from defects when critically examined in all sizes to warrant its adoption as a standard, even had it been considered desirable to do so; and your committee then decided to undertake the complete design of commercial sizes of malleable pipe unions for wrought iron pipe from ⅛ inch to 4 inches, inclusive, which we could endorse as a consistent design and submit as a proposed standard union. While this somewhat broadens the scope of your committee's work, it seemed the only practicable way to comply with our instructions.

The details of the design were worked out under the personal direction of Mr. Vogt, of the committee, who has prepared the data, drawings, and tables of dimensions accompanying this report, as follows:

Plate A shows a ¾-inch union, drawn double size, with all dimensions numbered for reference to the accompanying Table B.

Table B gives the dimensions of all sizes of unions from ⅛ inch to 4 inches, the figures at top of column referring to corresponding dimensions on Plate A. The description accompanying Table B explains this table and where any radical departure is made from present practice, it is explained and the reasons given briefly.

Plate C is a diagram of dimensions of the proposed standard pipe unions, and shows all dimensions plotted to an arbitrary scale, the vertical dimensions representing tenths of inches, the horizontal the outside diameter of the pipe.

Plate D shows a longitudinal section, full-size, of each of the proposed standard pipe unions, through its axis and the middle of side of the nut.

It will be noted that all sizes from ½ inch to 4 inches have the pipe and swivel ends paneled where the pipe wrench engages. This paneling is not put upon the smaller sizes on account of the increase in size of the nut and dependent parts necessitated by putting the ribs on the ends, nor is it considered at all necessary on these sizes.

The mark S on the side of the nut is suggested for a designating mark which could be secured by this Society if it is deemed wise to pursue such a course. The committee recommends that this be copyrighted and the standard unions thus designated.

Under date of March 16, 1901, your committee, having completed the design of proposed standard union, wrote the following letter to eleven of the principal manufacturers and dealers in malleable iron pipe unions:

"The undersigned were appointed a committee of the American Society of Mechanical Engineers to consider the matter of a standard union for ordinary sizes of pipe. After a thorough study of the situation, and finding that no two manufacturers of unions made these parts interchangeable, it was decided that, in order to establish a standard union, the committee should proceed on lines entirely free from the consideration of any special sizes or dimensions now used by manufacturers, excepting that the part of the union which is screwed upon the pipe should conform with the Briggs Standard Pipe Threads as recently recommended by this Society, the American Railway Master Mechanics' Association and the Master Car Builders' Association. Acting upon this decision, a line of malleable unions has been designed, and we are enclosing you, under separate cover, the following in connection therewith:

"One blue-print from drawing No. 15,427, showing dimensions of ½-inch and 2-inch unions.

"One blue-print, dated Altoona, Pennsylvania, June 15, 1900, showing diagrammatically 'Proposed Proportions for M. I. Pipe Unions' for all sizes of pipe from ⅛ inch to 4 inches, inclusive.

"One blue-print from drawing No. 15,009, showing ¾-inch union drawn double size and with all the dimensions numbered.

"One copy 'Description Accompanying Table of Malleable Pipe Unions.'

"One copy 'Proposed Dimensions for Pipe Unions.'

"The dimension numbers on print from drawing No. 15,009 have reference to the table of dimensions mentioned. We believe this information will enable you to clearly see just what the committee proposes to submit to the Society as a design for standard malleable iron unions. Before formulating our report, we cordially invite you, as a manufacturer of unions, to favor the committee with any suggestions, criticisms, or advice you may be able to give, in any way affecting these unions, either from the manufacturers' standpoint or the standpoint of the dealer or user of these devices.

"Thanking you in advance for any consideration you can give to this matter, we remain."

Two of those receiving such letters favored the committee with suggestions and criticisms which were all carefully considered and the design, modified in the light of these suggestions, was again submitted to the same parties under date of November 8, 1901, as follows:

"The committee appointed by the American Society of Mechanical Engineers, on Proposed Standard Unions, having received certain criticisms and suggestions from the manufacturers, to whom the proposed design was previously submitted, takes pleasure in sending you herewith the following prints, etc., showing the design as modified after full consideration of the criticisms received, namely:

"One print 'Proposed Standard Pipe Unions.' dated June 5, 1901, showing full-size section of proposed unions as modified by the committee.

"One blue-print No. 15,009-A, showing ¾-inch union, drawn double-size, with all dimensions numbered.

"One copy 'Description Accompanying Table of Malleable Pipe Unions,' dated November 7, 1901, explaining fully the dimension lines.

"One copy table 'Dimensions for Proposed Standard Pipe Unions,' dated November 7, 1901, giving actual dimensions for each size of union.

"One blue-print showing modified diagram of dimensions, dated October 14, 1901.

"We would ask you to again make a careful examination of this design as shown and favor us with any criticisms or suggestions which you may have to make either from the standpoint of the manufacturer, dealer, or user of these devices. As it is the committee's earnest desire to submit their report to the Society at the next meeting, which occurs early in December, we would ask that you let us hear from you as promptly as possible.

"Thanking you in advance for an early consideration of this matter, we remain."

To this communication, with the exception of acknowledgment of its receipt, no replies have been received.

Through the courtesy of Mr. Stanley G. Flagg, Jr., a number of ½-inch and 2-inch malleable unions have been made for your committee from patterns prepared from the designs for proposed standard pipe union. These unions have been tested to destruction in two ways:

First, Tensile Test.— A round bar of iron, threaded with proper size pipe thread, was screwed into each end of the union and a tensile strain was put upon it until rupture occurred. Where the casting was good, the breakage generally occurred from the sharp corner under the collar on the nut, or under the collar on swivel, indicating that the uniformity in strength aimed at in the design was probably affected by the sharp corner left by finishing the bottom of the nut and the collar on swivel end. The strength seems ample, however, so no change in the dimensions is recommended. The average breaking stress of eight pieces, ½-inch, was 11,200 lbs., minimum 9,850 lbs., maximum 12,080 lbs.; of 2-inch, the average was 34,450 lbs., minimum 28,800 lbs., maximum 38.600 lbs.

Second, Transverse Tests.— Made by screwing a round bar of iron, threaded as before, into each end of union nut, these bars being of sufficient length to be supported eleven inches either side of the center of the union, load being applied on center of union nut. Breakage occurred at different points indicating fairly uniform strength. The average breaking stress of three pieces, ½-inch, was 730 lbs., minimum 710 lbs., maximum 750 lbs.; of 2-inch, the average was 7,930 lbs., minimum 7,800 lbs., maximum 8,000.

Bursting tests were also made with ½-inch and 2-inch unions by putting a pressure of water upon the union when fitted to piping. The pressure was gradually increased to 1,200 lbs. per square inch, the

THE PRESIDENT: The next business is the presentation of an individual paper by Mr. F. M. Whyte, entitled, "Modern Water Supply Stations for Locomotives."

MR. WHYTE: When I accepted the invitation to write such a paper, I did not appreciate how broad the subject was. The further I got into the subject the more difficulty I got into. The subject as at first proposed by the Committee on Subjects referred only to Water Scoops, but the Executive Committee enlarged the subject when assigning it to me and made it include water supply stations in general.

Mr. Whyte read the following paper:

MODERN WATER SUPPLY STATIONS FOR LOCOMOTIVES.

BY F. M. WHYTE, M. E., N. Y. C. & H. R. R. R.
(A Member of the Association).

I.

PREFACE.

The subject. The original wording of the subject when proposed by the committee limited its treatment to the construction of shallow tanks, track tanks, which are placed between the rails of a track; and to the scoops which are placed on locomotive tenders, and through which the water is raised from the track tank to the tender tank while the locomotive is in motion. It was appreciated, however, by the Committee on Subjects and by the Executive Committee, that consideration of only the track tank and water scoop would be of interest to only a few railroad officials, and therefore the subject was made as broad as possible, by wording it as above. A thorough treatment of track tanks and water scoops would give ample material for a paper, but, no doubt, the broader subject, treated more hastily, will be of more general interest. Those who changed the wording of the subject desired, probably, to interest the greatest number. The writer hopes that this paper may merit such a broad interest in the subject as the committee desired.

Experience o writer. The officials of the motive power department of some railroads have supervision of the water supply and of the means for providing it, but the writer has not had personal experience in the water-supply department, except as experience in designing, testing and maintaining water scoops for locomotive tenders may be considered as a part of that department; therefore, the paper must be much like a report with the end in view of showing the present "state of the art." This explanation is due to the reader in order that he may know what value to attach to the paper as a whole, as well as to the few opinions of the writer which may be expressed.

II.

MEANING OF THE SUBJECT.

The word "modern" in the title has, in its relation to the subject, no meaning or many meanings, depending upon how it is interpreted. An effort to design a water supply station for locomotives which should be "modern" for any very large section of country would be fruitless, because in some sections the crudest kind of a water station is at present the most modern, and track tanks and water scoops, which are considered very necessary in some places, would be simply absurd in other places. For instance, where water is hauled for miles in transport cars from places where it is obtainable to places where it is needed and not otherwise obtainable, the use of track tanks should not be considered. In districts where the usual supply of water is of a quality unsuited for boiler purposes, purifying plants may be necessary in connection with the water station, or the construction of reservoirs in which to collect and store rain water may be desirable, if not necessary, and such plants would not be necessary at other water stations; a water-supply station with a purifying adjunct may be very appropriately quite a different sort of station from a station without such addition. So it will be appreciated that it is not possible to point out *the* modern water-supply station, and recourse must be had to showing some of the many modern water-supply stations. As a further illustration the Association of Railway Superintendents of Bridges and Buildings were unable, at their latest meeting, to decide whether wood, iron, tile or concrete was most desirable for the reservoir tank, and of what material it is best to make the substructure.

III.

SOURCES OF WATER SUPPLY.

Sometimes there is a choice of sources of supply, and no doubt it is true that, in general, a comprehensive study of the location of sources of supply for any district, of the distribution of supply stations, and the adaptation of the capacity of the tank of the locomotives, there may be created a possibility for a choice of source of supply. Of course, the officials of the operating department would have a water station wherever it is possible to get water, so that there would be no chance of keeping a locomotive where water is not to be had, but on the whole these officials are reasonable in their demands. It happens too frequently that where a choice is possible and desirable only the convenience of making the necessary connection is considered. Sometimes at a small cost additional to the cost for connecting to a near-by stream it will be possible to take the supply from another stream or other source of much better water, and this additional cost be saved many times over by the reduction in cost of keeping locomotive boilers in repair. A considerable cost for a well or for a reservoir for surface water, even when water from a stream is easily available, but which stream is polluted from mine, manufacturing plant

or city sewage, may be offset by reduction in cost of boiler repair. It requires extremely good judgment to decide what expense necessary to get a supply of good water can be met by the reduction in the cost of keeping boilers in condition, and the official must be of large experience who will take from the pocket with one hand a tangible sum of money, and drop it into what he considers a "grab-bag," with the hope of getting it and more with the other hand. He sees in one hand a definite amount of money and in the other a "paper" credit made up of various items, such as a greater number of days' service for the locomotives, reduction in the cost of washing out and repairing boilers, and he clings to the gold and tears the "paper credit."

The principal considerations concerning the source of supply are to get the best water possible for the allowable expense, and to get it in amply large quantities. It is considered not within the province of this paper to treat further of the sources of supply.

IV.

POWER FOR PUMPING.

Pumping Power, General.

There is provided in various ways the power which is necessary to deliver the water from the place where it is obtainable to the place where it is needed before delivery to the locomotive tank; the most acceptable way, and the one which too frequently can not be used, is that of gravitation. At the ideal water-supply station the water is delivered from the source to the locomotive tank by gravitation. In so far as maintenance of machinery and handling of the same is concerned the equivalent to a railroad of the gravity supply is to purchase water from another corporation which does the pumping, usually towns and cities. Generally, however, the railroad does its own pumping, and a short reference should be made to the means which are used.

Wind power.

Probably the cheapest power that can be used for the purpose is wind power; but before deciding to depend upon the wind to do the pumping, it will be well to ascertain whether such dependence is advisable. In some of the Western States the average velocity of the wind is greater than the average velocity in the Eastern States, and as a result wind power has been used for pumping more extensively in the West. It is necessary to have each plant thoroughly reliable, so that the tendency now is to supplement the wind power with other more controllable power. It will be appreciated, however, that sufficient water must be pumped by wind power at lower cost than for pumping by other power, to save the interest and depreciation on the wind power if the cost of the wind power, with an adjunct, is to be desired. When wind and some other kind of power are provided at one station, it is usual to connect both to the same pump rod; the connection for each kind of power being made in such a manner that either can be connected or disconnected quickly.

Steam power.

Pumps which are steam driven are used most generally for pumping water, and they can be used with much satisfaction where the water is

obtained within a reasonable distance below the surface of the ground and the demand for water is large and constant. There is experienced, frequently, much annoyance with deep well pumps because of the difficulty of getting at the pumps. Quite generally the pumping plant for a locomotive water station is so small that only the simplest arrangements are provided; the number of boilers is seldom greater than one or two, and because one man can attend this number and the services of one man are needed, labor-saving devices are not needed in the average steam plant. The boiler house is built as substantial as circumstances allow; it is located so that fuel can be taken to it conveniently and refuse taken from it. When the conditions allow, the boiler and pump are placed in the same building. The coal " shed " is, quite frequently, a gondola car placed on a siding near the pump house. and the attendant unloads the car as fast as the coal is required; at some stations it is being found advantageous to provide either a trestle so that coal can be dumped from the car and fall by gravity to the coal storage, or to depress below the ground level the boiler-room for the same purpose. The general use of hopper-bottom cars makes this possible, and the demand for cars and the fact that it is cheaper to store coal in a fixed bin than in a car makes the arrangement desirable.

Exhaust Connection.

The exhaust from the steam pump should be connected to the suction pipe at some distance from the pump, the steam being directed toward the pump where the steam enters the suction. This arrangement will assist the suction, reduce the back pressure on the steam end of the pump, and raise the temperature of the water, all of which are desirable results. Those who have used the arrangement give caution that care must be exercised to keep the exhaust pipes free from leaks.

Steam power is not quite as flexible as some other forms of power which are used, but there are a good many places where flexibility is not required, and where steam power either must, or should, be used.

Internal-combustion engines.

The internal-combustion engine, in the form of gas or gasoline engine, is being used more and more for providing power for pumping, and there are conditions which can be fulfilled very nicely with this kind of power. Where the work is intermittent, or can be made so, and the attendant is employed to advantage elsewhere when not attending the pumps, these engines have been used with much satisfaction. The gas engine or gasoline engine pump-house should be thoroughly ventilated at all times.

Using Hydro-Carbon.

It is the general practice to use gasolene in these engines, but quite recently it has been found that hydro-carbon, a by-product of the Pintsch gas plants, can be used in these engines, and when this hydro-carbon is available there may be a material reduction in the cost of operating the engine. If a road is supplying its own engines from its own gas plants a very convenient way for handling the liquid is to provide metal casks of a capacity of about fifty gallons; or a sufficient number of tank cars may be provided, the cars to be sent out over the line and stopped wherever a supply of oil is needed, the oil tank at the pump-house filled, and the tank car moved on to the next station.

These engines may be handled in such a way as to be extremely economical from the standpoint of labor costs; they can be so arranged that the only labor shall be that of starting the engine, it being cut off automatically when the water tank is filled. The labor cost, then, is such as is necessary to provide sufficient attention to start the engine before the tank is emptied. Labor Cost

The usual arrangement of oil tank is to place this below ground, at some distance from the pump-house; this precautionary measure is to be commended, but some provision should be made for an inspection of the tank at intervals, to guard against undiscovered leakage.

Compressed air is used for raising water, and that there is a particular field for this form of pumping need not be proven. The requirements for such a system are an air compressor, and, of course, some means of driving it; frequently the compressor is run by a gasoline engine, and the two may be made very compact. Compressed air.

Compressed air gives a very convenient means of raising water from deep-driven wells, because the operating machinery is all above ground and the pipes, if they are found out of order, are easily and quickly replaced. Another condition which justifies the use of compressed air is the necessity of using a number of wells to provide the necessary quantity of water, allowing the water from the various wells to flow either to the place where needed, or to flow to the suction of force pumps. The air-lift will not deliver the water horizontally to any great distance, so that when the lift, or well, is at a greater distance than forty feet from the place where the water is to be used it is necessary to raise the water perpendicularly at the well to such a height that it will be delivered by gravitation to the place desired, or to provide other means for the horizontal delivery. The construction of such wells is probably so thoroughly understood that only a few words are necessary here, that there may be left no possibility of misinterpreting to what reference is made. There is the pipe projecting into the well, and through which the water is to be raised, and there is another pipe, or passage, through which compressed air may be delivered to a place near the bottom of the well, where there is connection between the air passage and the water-delivery pipe. Uses of Air Lifts.

This means of pumping can be used to advantage also when it is desired to locate the pumping machinery at some distance from the well. This condition may arise when it is difficult to get the machinery or the fuel for operating it, sufficiently close to the well; or when it is possible, by locating the machinery at some distance from the well, to keep the attendant busy at other work, when his services are not required all the time for pumping water. Also compressed air may be available for other service at the place where required, and in the use of it for raising water a considerable economy may be shown.

A very interesting example of the use of compressed air is shown in Fig. 1, which shows the details of the water system at the Denver shops of the Colorado & Southern Railway. Information concerning this arrange- Example of Air Lift.

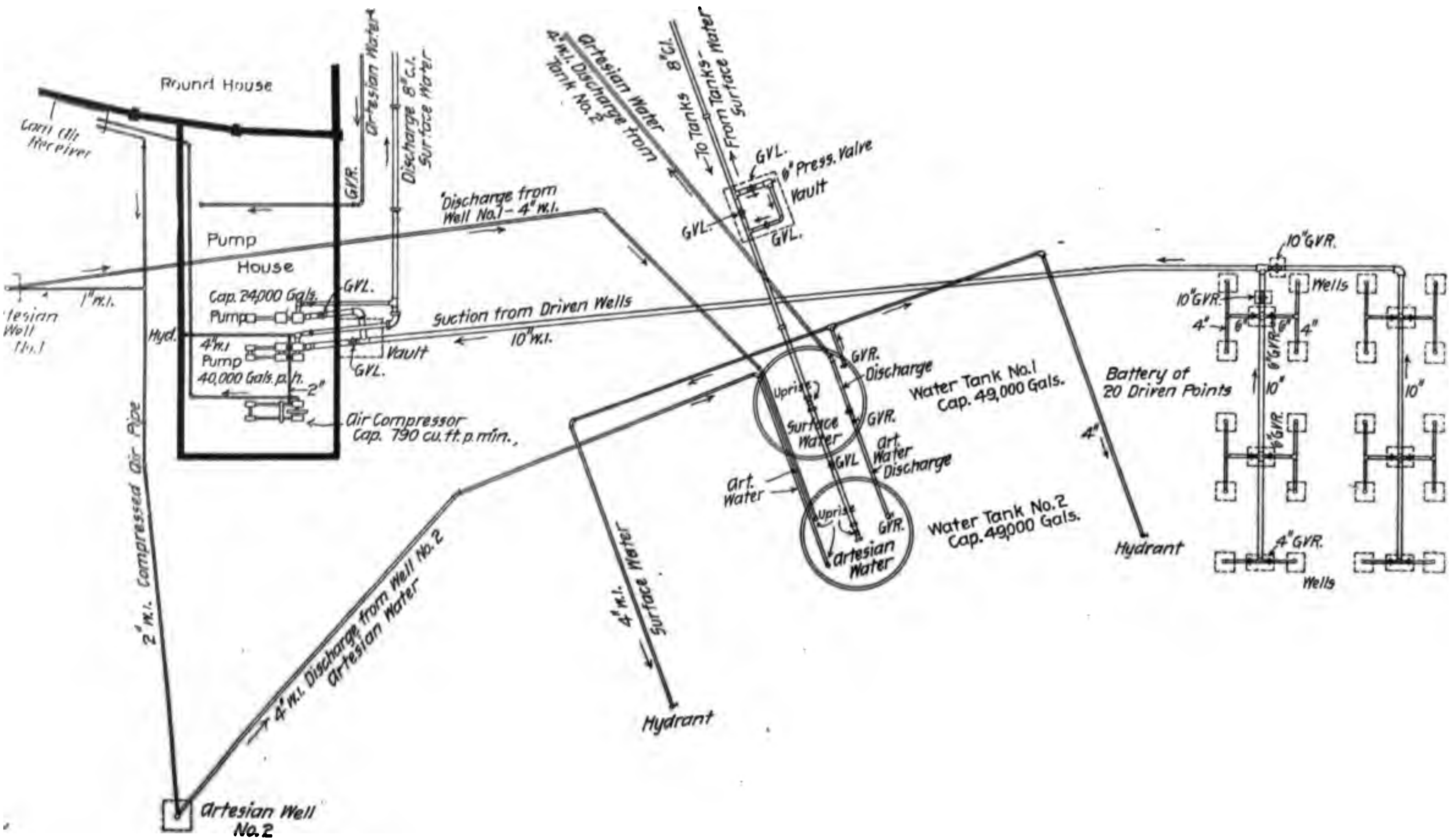

Round House
Pump
House
Cap. 24,000 Gals.
Pump
4" W.I.
Pump
40,000 Gals. p. h.
GVL.
GVR.
Vault
Hyd.
1" W.I.
Air Compressor
Cap. 790 cu. ft. p. min.
Artesian Water
Discharge 8" C.I.
Surface Water
Discharge from
Well No. 1 - 4" W.I.
Suction from Driven Wells
10" W.I.
2" W.I. Compressed Air Pipe
4" W.I. Discharge from Well No. 2
Artesian Water
Artesian Well
No. 2
Artesian Water
4" W.I. Discharge from
Tank No. 2
8" C.I.
To Tanks
From Tanks
Surface Water
6" Press. Valve
Vault
4" W.I.
Surface Water
Hydrant
Uprise
Surface
Water
Discharge
Water Tank No. 1
Cap. 49,000 Gals.
Art.
Water
Discharge
Art.
Water
Artesian
Water
Water Tank No. 2
Cap. 49,000 Gals.
Battery of
20 Driven Points
Hydrant
10" GVR.
Wells
6" GVR.
4" GVR.

Fig. 1.

ment was furnished by Mr. H. W. Cowan, chief engineer. There are two artesian wells, seven hundred feet deep, in which the water rises to within 160 feet of the top, and twenty surface wells twenty-seven feet deep, in which the water rises to within five feet of the top. The water from the artesian wells is used for boiler purposes, and the surface water is used for washing and for other similar purposes. The illustration shows the full layout in detail, and further description will not be necessary. It is an interesting example of the principle.

Proportioni Air Lift.

Information concerning the proper proportioning of air lifts has been the result of experience obtained by those who are engaged in making air compressors and in designing air lifts, and the formulæ which have been deduced from experience are treasured highly and are not available for publication. The general practice is, however, to make the relation of the submersion to the lift from 4 to 3, to 3 to 2. This is the "working" submergence as distinguished from the height at which the water stands in the well before pumping is begun; generally the water level in the well falls as soon as pumping is begun. If a lower percentage of submergence is used the cost of operation is increased. The weight of the column of water above the air inlet is readily calculated, and this will equal the pressure at which the air must be delivered to the point where the air and water are mixed. The starting pressure will be greater than the working pressure. The working pressure, divided by the atmospheric pressure at the altitude of the well, will give a quotient to which, if unity is added, will give the number of volumes of free air required. The capacity of the well may be calculated by allowing fifteen gallons per square inch of cross section of pipe per minute, or by taking the rate of flow in the discharge pipe at five feet per second. For heights of from fifteen to fifty feet there will be required two to three cubic feet of air at atmospheric pressure per cubic foot of water delivered; for heights of from fifty to one hundred feet it is considered best to provide three to six cubic feet of free air at atmospheric pressure for each cubic foot of water delivered. The efficiency of this system of pumping is about fifty per cent maximum, and may be as low as fifteen to twenty per cent.

Efficiency.

The water is not raised usually by air pressure; the air mixes with water in the delivery pipe, making the weight of the column of water and air in the pipe less than the weight of the column of water outside of the pipe. Sufficient air must be mixed with the water to make the difference in weight of the column inside the delivery pipe and the one outside of it such that they balance each other when the column inside the pipe stands at a height slightly in excess of the height to which it is desired to raise the water. If more than the required amount of air is forced into the delivery pipe the cost of raising the water will be needlessly high. The water may be forced to a considerable height by increasing the air pressure, but the expense in so doing becomes excessive.

Other mea pumping.

Other means than those mentioned in the foregoing are used for pumping water for locomotive supply, but the above are referred to at greater

length because they are used most universally. Water power, transformed in various ways, is sometimes used. Electricity has not been used to any great extent, but no doubt it will be used in the future much more than it is at present. Pumps driven by electric motors can be made automatic for both starting and stopping, so that the only attention necessary is for oiling and inspection. These pumps will be used where the electricity is available from supply furnished for other purposes, and where the amount used for pumping is a small portion of the total electrical power developed.

V.

TANKS, COLUMNS AND SCOOPS.

unks, etc., :neral.

It is found to be necessary, generally, to keep a supply of water at a place convenient for quick delivery to the tank of the locomotive, and it is therefore necessary to provide storage and a means for delivering the water from the storage to the tank of the locomotive; this leads to a consideration of such various structures and devices as are included under the designation "tanks," meaning the elevated reservoir tanks, water columns, cranes, penstocks, or by whatever descriptive name they are indicated; track tanks, or troughs, the shallow pans placed between the rails of a track, and from which water is scooped while the locomotive is in motion; and the scoop, at one time called a "jerk-water," by means of which water is scooped from the track tank. A chapter might be added about cars in which water is hauled for locomotive use, but even without such a chapter the paper will be too long; for this reason, and also because their use is very limited, it is considered best to make no further reference to them.

VI.

RESERVOIR TANKS.

.nks, ·cation.

These tanks are located close to the place where locomotives are to be placed while the tank of the locomotive is being filled with water. Sometimes the water is allowed to flow direct from the reservoir tank to the tank of the locomotive, and then, of course, the reservoir tank is placed close to the track. The reservoir tank and the valve and outlet-pipe for such an arrangement are shown in Fig. 2; the support for this tank is not shown in the illustration. The design of delivery-pipe shown in Fig. 2 is a good one, because it can be adjusted easily for locomotive tanks of different heights, and because it can be raised vertically to the clearing position there is no interference with the back coal-board on locomotive tanks nor with the adjacent end of a passenger car or other high car. This provision for delivering direct from the reservoir to the locomotive tank is not considered desirable, and in America, at least, new reservoir tanks are set back from the track, and the water is delivered to the locomotive tank through a water crane. There are several reasons for such a change; the reservoir tank is

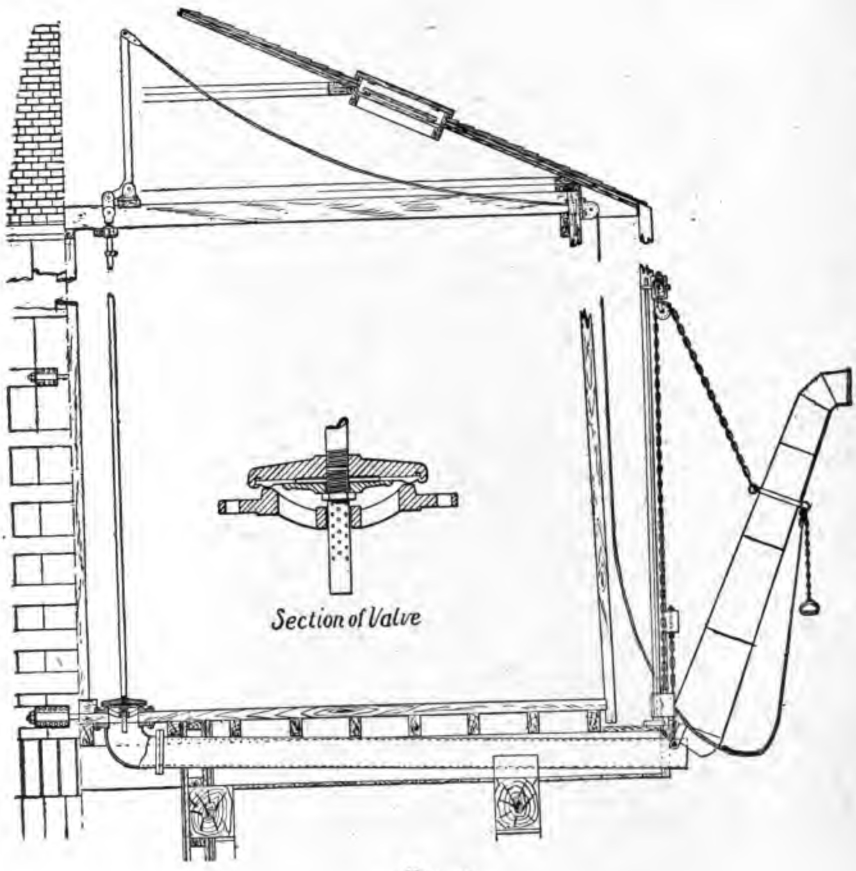


FIG. 2.

an unwieldy structure to handle in case of changes in track; and very serious accidents are possible if, from any cause, the tank falls. It is considered best to put them more out of the way.

ak
tlet valve.

When the reservoir tank is placed near the track for delivering water direct to the locomotive, the outlet valve is placed near the bottom of the tank, as shown in Fig. 2. This valve should be protected against closing too quickly, lest there be experienced the more or less destructive shock produced when the flow of a large volume of water is suddenly stopped. Sometimes provision is made to box in this valve in such a manner that if it needs attention the flow of water to it may be cut off and the valve can be got to for the purpose of making the repair. This may be accomplished by closing the gate which separates the box from the reservoir proper, the box extending to the top of the reservoir. With such an arrangement it will not be necessary to drain the water from the tank when the valve is to be repaired. The provisions made for draining those outlet pipes which are outside of the reservoir are shown plainly in the illustration.

er tank
truction.
bstructure.

The kind of material of which these reservoir tanks should be constructed is not so closely defined now as it was a few years ago. Of course the foundation, or piers, will be made, generally, of some such material as stone, brick or concrete, depending upon what is cheapest and best for the particular location. There is not much room for argument while attention is directed only to the foundation, but immediately we get above the foundation we get into a fruitful field for discussion. The Association of Railway Superintendents of Bridges and Buildings have devoted some time to the consideration of this question of material for substructure and for tank, their latest report on the subject having been made at the October, 1901, meeting. The committee of that association sent out letters of inquiry, and received replies to the various questions asked, and as many of the answers are interesting in connection with this paper, these answers have been tabulated for more convenient reference, and the tabulation is given in Table I. It was unfortunate that the replies were not received from a more extensive territory. A person may be deceived easily by relying too much on the indications given by this table. For instance, all replies gave wood as the material used in substructure and in the tank, although the report was illustrated by drawings of a steel tank on brick and concrete substructure, a steel tank on steel substructure and a tank made of vitrified tile and steel. The steel in this latter is in the shape of hoops to hold the tile together; the hoops are buried in the tile. There are being built quite a number of steel tanks on steel substructure, and a few similar ones have been in use for several years: the indications are that the present time may be called a transition period, and that steel will be more generally used for these structures than it is at present.

ooden
bstructure.

There is shown in Fig. 3 the general appearance of a wooden tank, supported on a wooden substructure; the illustration is of a tank placed fifty feet high, whereas in the ordinary construction for railroads the bottom of the tank is placed at less height than this above top of rail, and when the

FIG. 3.

height of substructure does not require the posts are not placed at an incline to the vertical. The box which is central under the tank, and which extends from the ground to the bottom of the tank, is the frost box, or, more correctly, the frost-proof box; the inlet and outlet pipes are placed in this box when the location is in such climate as to make such protection necessary, and the box is made frost-proof. The accepted construction for this frost-proof box is to enclose with sheathing the space within the four middle columns, there being three or four courses of sheathing, with air space three or four inches wide, between each course, and a lining of building paper on each course of boards. The extent of this protection will depend, of course, upon the climatic conditions which are to be met. It is considered very bad practice to fill with sawdust or shavings the space between the sheathings. Further protection against freezing is sometimes provided by enclosing the whole substructure and placing a stove inside, the pipe from which will be placed beside the water-pipes, and the stove-pipe is sometimes extended up through the tank, a suitable cast-iron pipe being used through the water. If the inlet pipe discharges above the highest water level in the tank, provision can be made to drain this pipe as soon as the delivery is stopped, but with this arrangement the pump must be worked always against the maximum head. Sometimes the roof is constructed as simple as possible to provide a suitable covering, and in some localities it is found necessary to construct the roof in such a manner as to give protection against the lower temperatures. The illustration, Fig. 3, shows very clearly the bands and the locations of the same for holding the staves together.

Frost-proofing.

Tank capacity.

A very usual capacity for these tanks is approximately fifty thousand gallons, this capacity being obtained by making the tank 24 feet diameter inside and 16 feet high. Some tanks of larger capacity, one hundred thousand gallons, are used, but the 16 by 24 foot tank is quite usual. The tank is made, sometimes, rectangular, but this form may be considered rather the unusual. The Philadelphia & Reading has in use a number of rectangular tanks supported on stone foundations. These tanks were built years ago.

Metal substructure.

Sometimes wooden tanks are placed upon metal substructures, and the illustrations, Figs. 4 and 5, show very good examples of such construction. Fig. 4 shows a tank of one hundred thousand gallons capacity, supported upon a substructure made of rolled sections. The elevation of the tank is thirty feet. Fig. 5 shows a fifty thousand gallon tank, supported upon cast-iron columns; the elevation of this tank is about fifteen feet. Some men object to using metal substructure under a wooden tank, apparently because they consider that the wooden substructure will last as long as a wooden tank.

Metal tanks.

The difficulty experienced in getting good timber, the increasing cost of good timber, and the increasing tendency among railroad officials to make all structures of a more permanent nature, these several conditions have contributed to the selection of some material to be used instead of wood in the construction of tanks and the supports for the same. The

Fig. 4.

FIG. 5.

substitution may take the form of steel tanks supported upon a trestle of rolled steel shapes, supported upon stone substructure, or the steel tank may be continuous from the foundation at the ground level to the required height. In Fig. 6 is shown a steel tank placed upon a stone foundation, and in Fig. 7 is shown a steel tank which is continuous from the ground level. In the latter the lower ten feet or twelve feet depth of water can not be util-

FIG. 6.

ized, probably, for pressure, so that the choice of this tank or of another placed on higher foundation will depend largely upon the cost of building the tank or the foundation for the ten or twelve feet immediately above the surface of the ground, and upon the probable permanency of the structure. Fig. 6 shows the tank located at the Chicago shops of the Chicago, Rock Island & Pacific Railway, and Fig. 7 shows the tank located at Dover, New Jersey, on the Delaware, Lackawanna & Western Railway. Tanks which are made of steel and which are supported upon a substructure made of rolled-steel sections, are generally made with a hemi-spherical bottom, this

FIG. 7.

shape being used because it is self-supporting between the columns. Objections have been made to steel tanks, but the objections are made, generally, by those persons who have had no experience with them. Those persons who have had experience with steel tanks speak very favorably of such construction. It is supposed that some difficulty will be experienced in painting the interior surface of these tanks, but it has not been demonstrated yet that such painting will be necessary. Some persons point to the failures of steel tanks or towers which are used sometimes as adjuncts to municipal water supplies, but the tank used by railroads for locomotive water supply is quite a different structure, at the present time, at least.

Tile tank. A water tank has been constructed of vitrified tile, held together by steel hoops, the hoops being enclosed in the tile; this tank was supported at the usual height on tile foundation. There is being constructed another tile tank which will be continuous from the ground level up; it will be interesting to watch the results obtained from this tank, because the pressure outwardly at the bottom will be considerable. No difficulty is anticipated by those who are constructing the tank.

Cement tan Cement construction is offered for tanks, and the general design of such a tank is shown in Fig. 8. This is the Monier patent. Steel rods placed in the cement on the sides and roof and in the substructure, add to the rigidity. Tanks of this construction are offered in capacity of from twenty thousand gallons to one hundred thousand gallons.

Height of tanks. There is considerable variation in the height at which reservoir tanks are placed, but inasmuch as this paper has to do only with tanks for supplying water to locomotives, it will not be necessary to consider those tanks which are placed at a considerable height in order to provide high pressure for other kinds of service. If the water is to be delivered direct from the reservoir tank to the locomotive tank, through an arrangement similar to that shown in Fig. 2, then the height of the reservoir tank is fixed within the relatively close limits of heights of the locomotive tanks. If the reservoir tank is used to supply water to water cranes, the height is not fixed so positively, but it is not desirable to place the tank very high. The desire now is to deliver the water to the locomotive tank as quickly as possible, and as the rate of flow depends upon the velocity and the size of the stream, we are not confined to increasing the velocity, by raising the head, in order to increase the rate of delivery. It is much better to increase the size of pipe connecting to the water crane, and place the reservoir tank at an average height, possibly, of twenty feet or at even a less height, and get the desired increase in flow by increasing the size of the stream. The lower the tank the less the head against which the pumps must be worked, and as the cost of pumping varies almost in proportion to the delivery head, the importance of having the tanks low will be appreciated.

Capacity, tanks and pumps. It is conceded quite generally that the capacity of pumps and of tanks commonly used heretofore have been too small to allow of most economical operation, and the effort is now to provide such ample capacity for pump and for tank that continuous pumping will not be necessary. For instance,

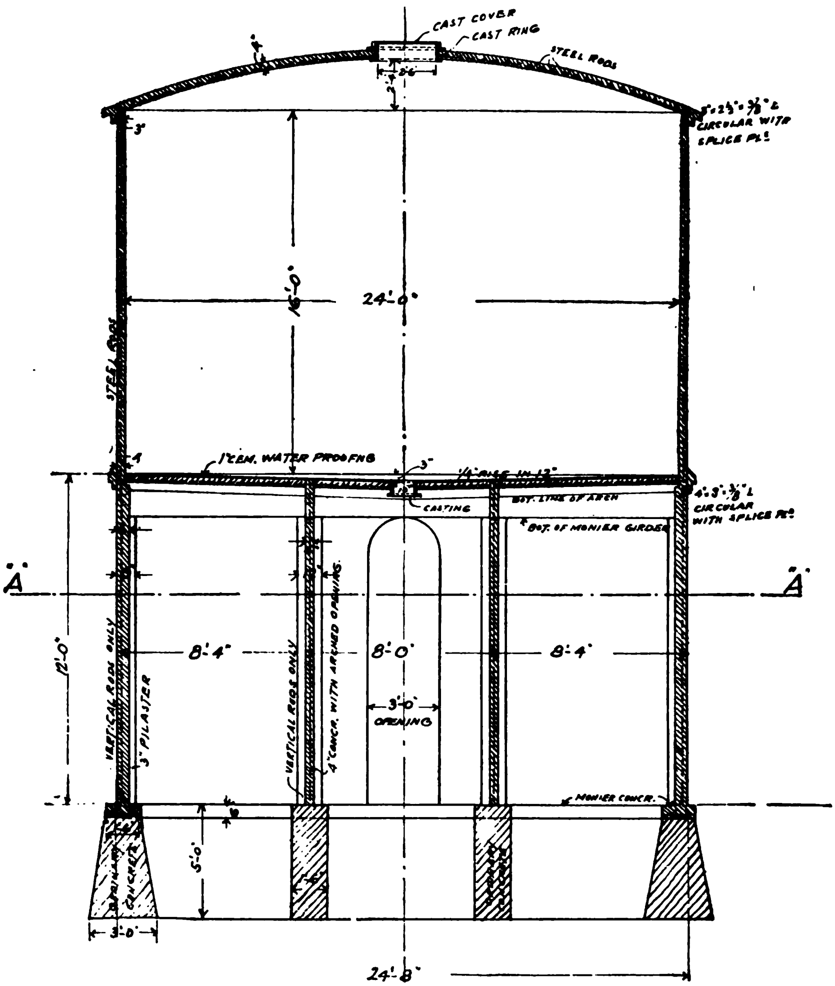

CAST COVER
CAST RING
STEEL RODS
24'-0"
16'-0"
STEEL RODS
1" CEM. WATER PROOFING
1/4" RISE IN 12"
CASTING
BOT. LINE OF ARCH
BOT. OF MONIER GIRDER
CIRCULAR WITH SPLICE PL.
A
A
12'-0"
8'-4"
8'-0"
8'-4"
3'-0" OPENING
VERTICAL RODS ONLY
3" PILASTER
VERTICAL RODS ONLY
4" CONCR. WITH ARCHED OPENING
MONIER CONCR.
5'-0"
CONCRETE
3'-0"
24'-8"

FIG. 8.

instead of providing a pump having such capacity that it must be run for twenty-four hours each day in order to deliver the amount of water required, and providing a tank just large enough to handle the water at the rate it is delivered by such a pump, it is much better practice to provide a pump of double the capacity, and have an attendant for twelve hours instead of for twenty-four hours. The tank will need to be large enough to contain the amount of water required for the twelve hours during which the pump is not operated, and even a larger capacity than this is recom-

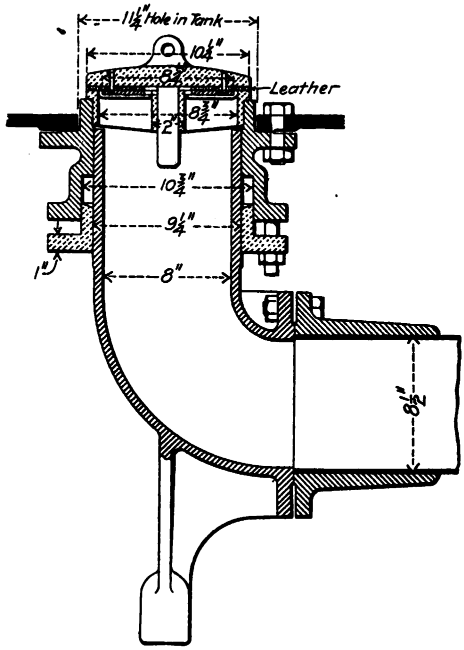


FIG. 11.

mended. The cost of attendance may be further reduced and the pump be operated for six hours, for instance, if the remainder of the working day can be utilized somewhere else. It will be best to investigate the subject separately for each station, offsetting the possible saving in labor by the additional interest and depreciation on pump and tank, and allowing some credit for the more satisfactory operation of larger pumps and tanks.

The foregoing relates more particularly to American practice. Requests for information and for drawings sent to several railroad officials in England were very generally replied to favorably and copies of drawings forwarded; several of the drawings are interesting in connection with the **English tank**

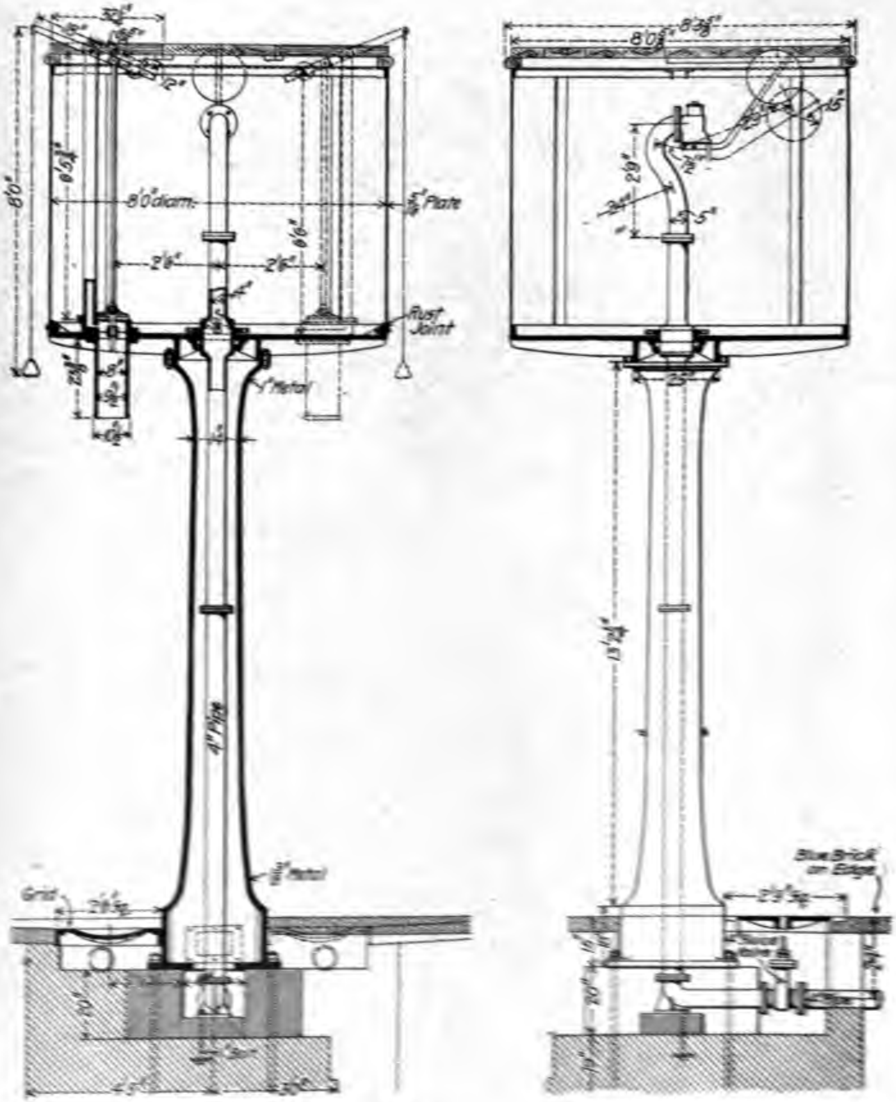


Fig. 9.

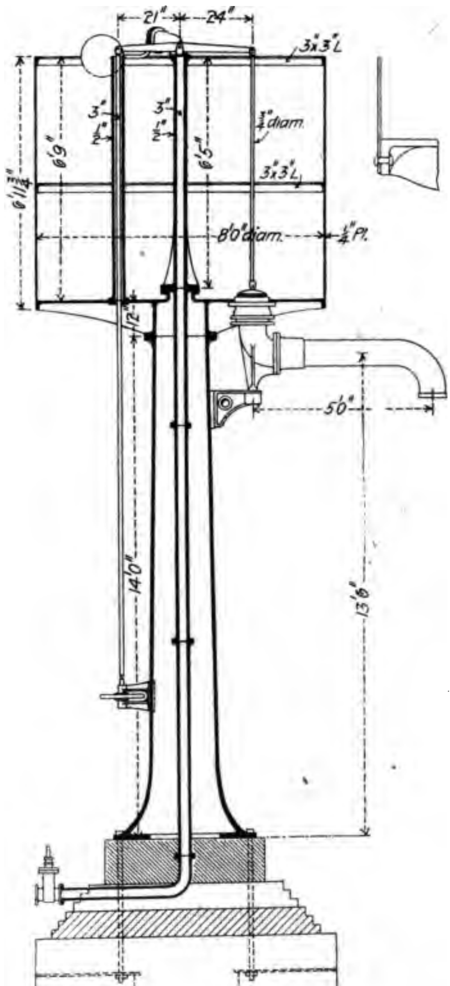

21"
24"
3"x3"L
3"
1/2"
3/4" diam.
6'9"
6'5"
6'11 3/4"
3"x3"L
8'0" diam.
1/4" Pl.
12"
5'0"
14'0"
13'6"

FIG. 10.

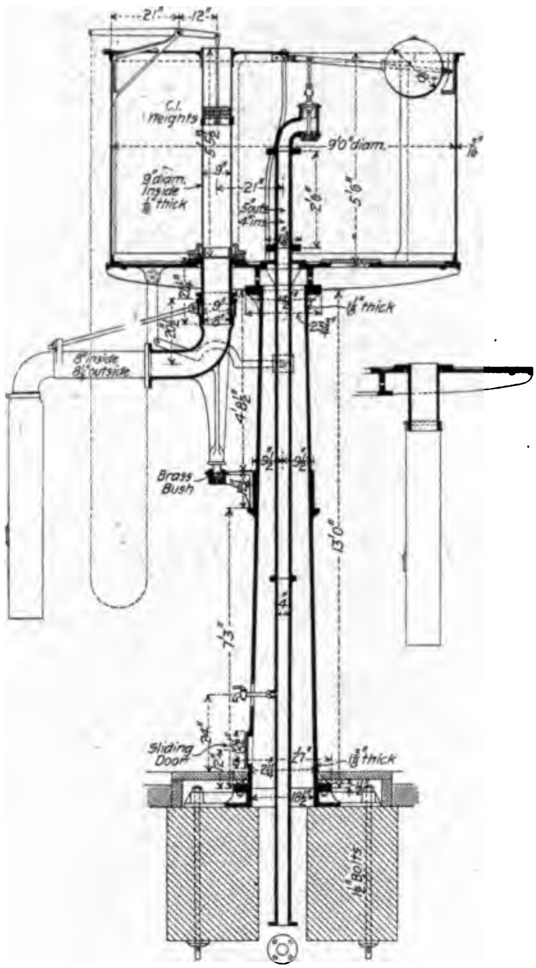

C.I. Weights
9'0" diam.
9" diam. Inside
8" inside
8½" outside
Brass Bush
Sliding Door
1½" Bolts

FIG. 12.

subject of reservoir tanks, and these will be treated of here, and the cranes and track tanks will receive consideration under the proper headings. The structures which are shown in Figs. 9, 10, 11 and 12 are sometimes referred to as tanks, sometimes as tanks and cranes, and sometimes as columns; the designation would indicate a structure intermediate between the American water column, or crane, and the reservoir tank, and the capacity and design seem to confirm this indication. There is shown in Fig. 9 the circular tank used on the London & Northwestern Railway. The capacity is two thousand gallons. The drawings were sent by Mr. F. W. Webb, chief mechanical engineer of that road. Fig. 10 shows the water tank and crane used on the Great Eastern Railway, the illustration having been made from a drawing sent by Mr. Jas. Holden, who has superivision of the locomotive, carriage and wagon department of that road. The outlet valve for this crane is shown in Fig. 11. The tank is about the same size as the others shown. There is shown in Fig. 12 the "Parachute Water Column" used on the Lancashire & Yorkshire Railway, the drawing having been sent by Mr. H. A. Hoy, chief mechanical engineer. The capacity of the tank is 2,000 gallons. The general principle for all of them is an inlet pipe about 4 inches in diameter, the valve in this pipe being controlled automatically with a float. There is an outlet pipe about eight inches in diameter which can be turned about a pivot to a position in which it will project over the locomotive tank, or which is placed two or three feet out from the center of the column, and the remaining distance to the locomotive tank being provided for with a suitable hose. A flexible hose may be used with the pivoted ones also. Presumably these tanks, even if made with such a capacity as to correspond with the locomotive tanks of 5,000, 6,000 and 7,000 gallons used in America, could not be used in places where the locomotives are placed for water at short intervals of time, but the idea and the construction of these tank-cranes will prove to be very interesting to the railroad men of America. These cranes have the advantage of a very direct delivery to the locomotive tank. There are used, also, in England, reservoir tanks which are very similar to those used in America.

VI.

WATER CRANES.

The crane, column, standpipe, penstock, or by whatever other word it may be designated, is essentially the vertical continuation of the water pipe supporting a horizontal section of pipe, which can be turned around so that the outer end of the pipe will be over the locomotive tender. A general idea of the appearance of a crane can be obtained from Figs. 13 and 14, although cranes made by different manufacturers have distinctive features. There is a valve for controlling the flow of water and the valve can be operated from the top of the crane or from the ground. When the reservoir tank is placed near enough to the track that the delivery can be made direct from the reservoir to the locomotive tank, as shown in Fig. 2, Cranes.

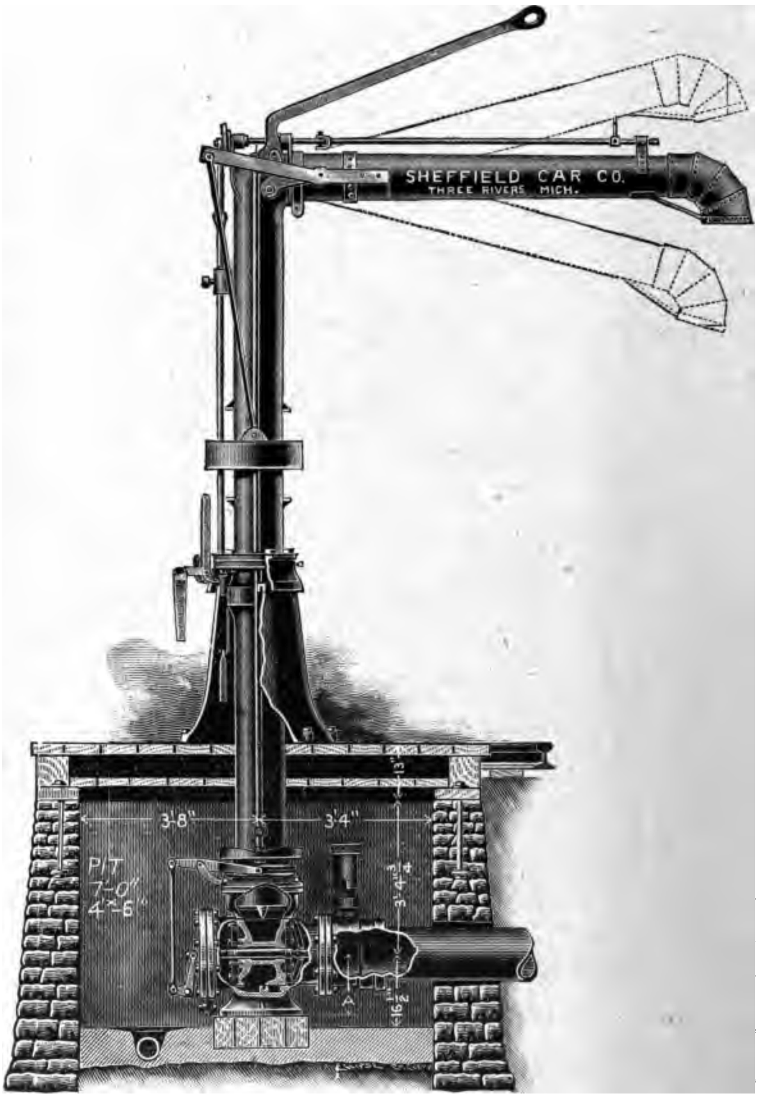

SHEFFIELD CAR CO.
THREE RIVERS MICH.
3'8"
3'4"
13"
3' 4 3/4"
PIT
7'-0"
4'-6"
A
16 1/2"

FIG. 13.

FIG. 14.

the crane is not necessary; but, as indicated in a preceding paragraph, it is considered desirable to locate the tank in a less exposed place and use a crane. Cranes are necessary where the reservoir tank can not be located conveniently for delivery direct to the locomotive tank. The water for the crane is generally supplied from a reservoir tank. The present rush of both passenger and freight business makes necessary the saving of every minute possible, and more attention is being given to means for delivering quickly the water to the locomotive tank; with the object of delivering the water as promptly as possible, the pipe from the reservoir tank to standpipe is made larger in diameter than was commonly the practice; the crane, or standpipe, is made larger; and the valve is made with a more direct passage for the water. In fact, a serious study is being made of the friction of water in pipes, valves and bends, and as a result some previous designs are being revised or discarded. It will be appropriate to give here the results of some tests made by Mr. T. W. Snow. A 90-degree bend of a radius equal to one and one-half times the diameter of the pipe, for pipes 8 to 14 inches in diameter, offers a resistance to the flow of water equal to that of 100 feet of straight pipe; a 12-inch pipe, 300 feet long and having three bends of 90 degrees each, the head being 24 feet, gave a flow of 4,000 gallons a minute; under the same conditions, except that the length of the pipe was 900 feet, the flow was 3,200 gallons a minute. With an improved standpipe, the flow under conditions similar to the first instance given above was increased to 5,000 gallons a minute. These data will impress the necessity of having direct passages. Of course, there are various designs of cranes and each is given peculiarities which are held out as inducements to prospective buyers, but it is impossible to refer to them here; there are some things, however, which are considered essential features, and some of these may be mentioned. The pipe connecting the reservoir tank and the crane should be larger than the crane; one size larger seems to be in accordance with improved practice, and the change in diameter is made just outside of the crane pit, or as close to the valve as possible. Some device should be provided to protect the pipe and the valve against shock due to sudden closing of the valve. The valve passages should be made as direct as possible, so that the resistance to the flow of water may be the minimum; this should be considered in connection with the 90-degree bend, which must be made in changing direction from the horizontal delivery pipe to the vertical standpipe. It should be possible for a person to operate the crane while standing on the ground and also while standing on top of a tender. The standpipe, for cold climates, should be drained automatically when the controlling valve is closed. The arm should have considerable motion in a vertical plane, so that there will be some adjustment possible to accommodate for locomotive tenders of different heights, and to clear the better the coal board and the ends of cars. It should be positively locked in the position parallel to the track, so that it can not be blown by the wind, or placed accidentally into the position to foul trains. Drainage must be provided for the crane pit. For proper security a gate valve should

of water
…es.

…al
…rements
…anes.

be placed inside of the crane valve, and there should be another valve near the reservoir tank. The pipe should be given a coat of asphaltum inside, to reduce friction; and the velocity head may be reduced by making the inlet in the shape of a funnel. The piping arrangement shown in Fig. 15 has been prepared by the Otto Gas Engine Works, and is presented as an ideal; the crane valve shown in this cut is not their most direct one. The Sheffield standpipe is shown in Fig. 13; the Mansfield crane is shown in Fig. 14; the valve and the automatic closing device for the Poage columns are shown in Figs. 16 and 17.

Size of crane. Table 1 does not indicate the present approved practice for diameter of water crane and for diameter of pipe leading to it; the tendency is toward cranes of larger diameters, 10 inches and 12 inches in diameter, and the pipes leading to them are respectively 12 and 14 inches in diameter. The height of the outlet of the crane above top of rail is controlled by the height of locomotive tank, but that locomotive tanks will not always be a fixed height, the tendency being to higher ones, has been overlooked sometimes and the cranes have had to be lengthened.

Location of cranes. It may not be out of place here to refer to what appears to have been an oversight in planning the water-supply systems of the railroads in America, at least. It seems, sometimes, that the idea has been that a water tank or column in sight is as good as one at hand, and as a result locomotives are delayed near water stations until other locomotives are supplied with water. Large switching yards are provided with one or two cranes, usually near a short ash-pit, and several times a day a line of locomotives may be seen near the water station, the crews waiting their turns to get water. There must be done just so much work and just so much water must be used to do it, and it is cheaper to deliver the water in pipes to the locomotives than to run the locomotives to the water station if the stations are not conveniently located. With the cranes conveniently located in a switching yard, the locomotive tanks need not be of extreme capacity; and it is expensive to switch water backward and forward. The apparent saving in cost of pipe and cranes may be a false economy.

English and American cranes. The possibility of misunderstanding between an Englishman and an American in a discussion of water cranes, columns, penstocks or whatever designation is chosen, is illustrated in the correspondence between the writer and a firm of manufacturers in England; in reply to a question concerning the largest size of penstock they are asked to furnish, they advise the maximum are 10 feet by 4 feet 6 inches, oval, and 6 feet 9 inches, circular; the smallest being 4 inches, and the average size being 18 inches to 24 inches. Presumably the largest ones are like those shown in Figs. 9, 10 and 12.

Crane used in India and other English colonies. There is shown in Fig. 18 a pillar water crane which is made by Clay, Henriques & Co., Ltd., of Dewsbury, England, and which that company advises is used throughout India, and is used largely by most of the colonial railway companies. It is made in two sizes, 6 inches and 8 inches in diameter. The method of operating the crane is explained as follows:

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ın pi

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requ
for

The valve is worked from the ground by means of the chain and sprocket wheel, or from the locomotive by means of the hand wheel at the end of the arm; through these are driven the pair of bevel-gear wheels located at the top of the pillar; through these gear wheels is driven a vertical spindle, which is placed inside of the center column; by means of the spindle the valve is operated; the valve is of the mushroom type. The arm is supported by means of the roller wheel, near the top of the column, on an inclined bearing, so that the weight of the arm returns the arm to the position parallel with the track and the arm is held in that position.

Cranes used England.

Some idea may be obtained of the designs of water columns which are used in England by a study of Figs. 19, 20 and 21. There is shown in Fig. 19 a new 10-inch water column which is in use on the Midland Railway, and drawings of which were sent by Mr. S. W. Johnson, chief locomotive superintendent. The valve is placed immediately in the bottom of the column, where a brass bushing is provided for a seat. The valve is operated by a lever, the operator standing on the ground. The size of the pipe leading to the column is not given. The illustration makes the design easily understood. The column used on the Great Eastern Railway is shown in Fig. 20, drawing of which was sent by Mr. Jas. Holden, locomotive, carriage and wagon superintendent. The water crane used on the Great Western is very similar, the important difference, for general consideration, being that the controlling valve is horizontal instead of the vertical gate-valve shown in the illustration, and the pipe which leads to the column is 8 inches in diameter inside for the Great Western Railway instead of ten inches for the Great Eastern Railway. These columns are operated from the ground. There is attached, usually, to the outer end of the arm, a pendent hose to reach the opening in the locomotive tank. At the Reading station of the Great Western Railway the water cranes are distant several hundred feet from the reservoir tanks, and the pipe leading from the tanks is twelve inches in diameter; it is decreased in diameter as other leads are taken off and is eight inches in diameter at the cranes. The tanks are 30 by 20 by 8 feet and 40 by 20 by 8 feet. An examination of the water-supply system at this station impresses a person that it was considered better policy to provide a sufficient number of cranes than to be waiting for the services of a crane. The water column used on the London & South Western Railway is shown in Fig. 21, drawing of which was sent by Mr. J. W. Jacomb-Hood, resident engineer. The peculiarity of this column will be noticed at once; the controlling valve is placed in the vertical pipe. The sectional view of the valve makes its operation easily understood. The column is about eight inches diameter, inside.

There is much in these designs which were sent from England which will prove extremely interesting to the railroad men of America.

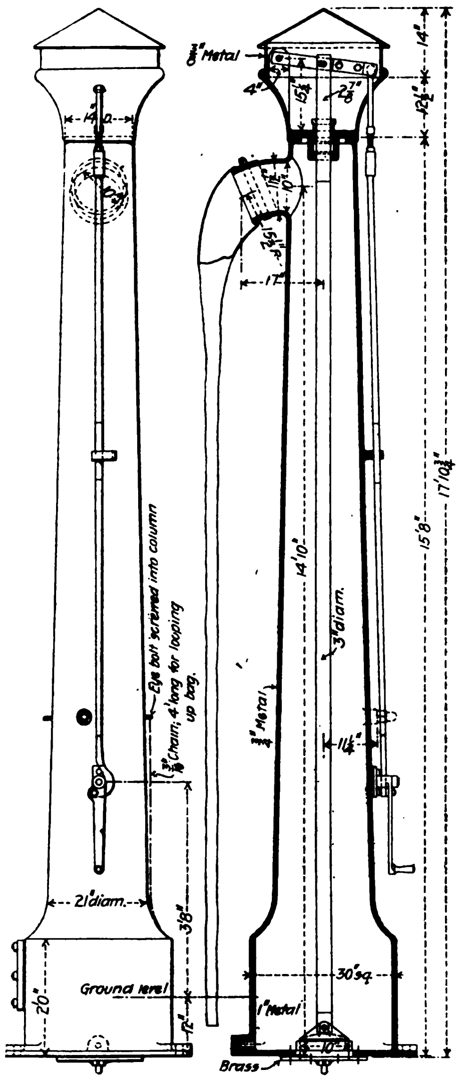

Eye bolt screwed into column
$\frac{3}{16}$" Chain; 4' long for looping up bag.
21" diam.
3'8"
2'0"
Ground level
12"
$\frac{3}{8}$" Metal
Metal
14'10"
3" diam.
30" sq.
1" Metal
10"
Brass
14"
15'8"
17'10$\frac{3}{4}$"
17"

FIG. 19.

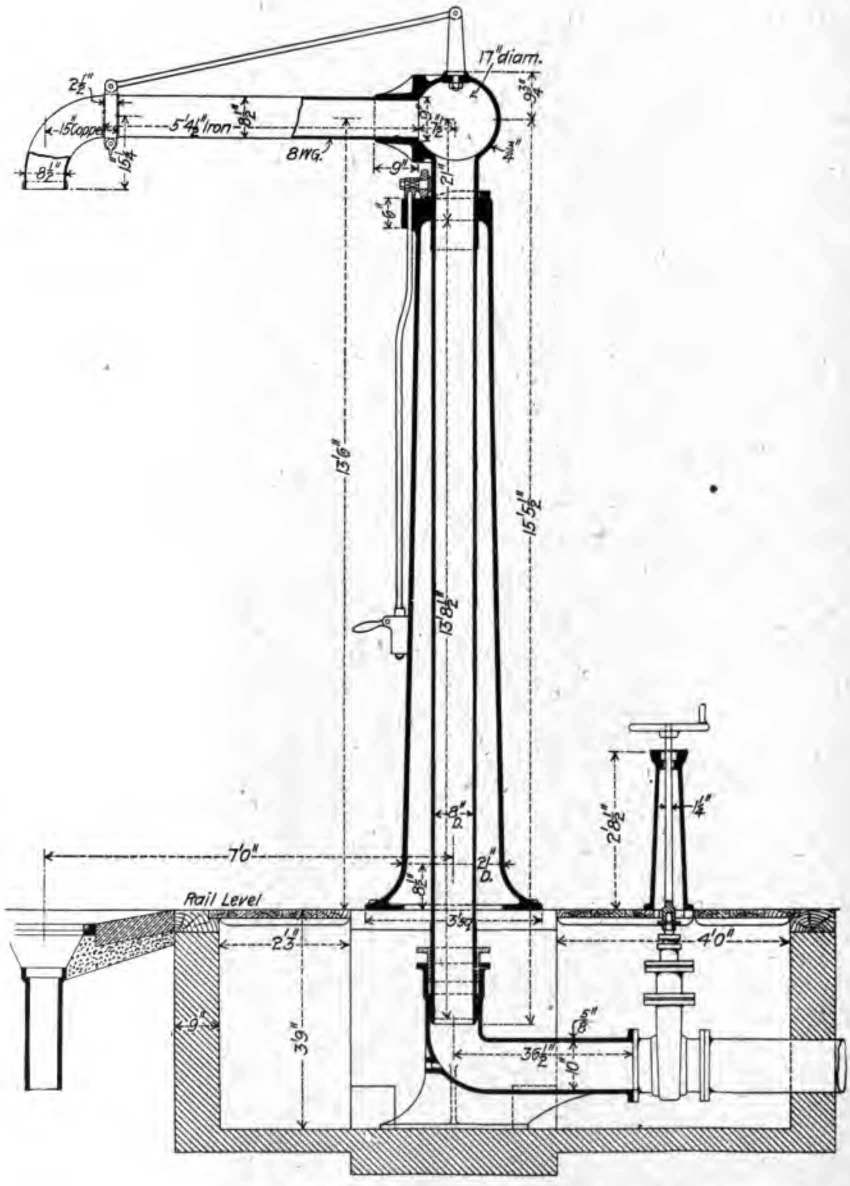

17"diam.
5'4½"Iron
15"Copper
8WG.
Rail Level
7'0"
13'6"
13'8½"
15'5½"
2'8½"
4'0"
2'3"
3'9"
3'5"
36½"

FIG. 20.

VII.

TRACK TANKS.

Track tanks are made six inches or seven inches deep and eighteen inches to twenty inches wide; they are placed central between the rails of a track, and the top of the tank, or, more particularly, the level of the water in the trough, must bear a fixed relation to the top of the rail. In America it is general practice to support the tanks directly on the cross-ties, the cross-ties being cut out to a depth equal to the difference in depth of the track rail and the tank; in other words, the top of the tank is placed generally at the same elevation as the top of rail; Fig. 23 shows this and other illustrations show it also. In England the tank is supported, usually, upon wooden stringers, which rest on the cross-ties; Fig. 34 illustrates this form. The tanks are of various lengths; some are 1,200 feet long, others 1,400 feet long, and others are 1,600 feet long, and the Lake Shore & Michigan Southern is making them 2,500 feet long where there is room. The length is determined by the maximum amount of water which is to be delivered into one locomotive tank, or the track tanks are made of sufficient length that the tanks of two locomotives coupled together can be filled with water; this is to provide for "double-heading"; the scoop of the leading locomotive is dropped at the approach to the track tank, and the scoop of the other locomotive is dropped when the middle of the track tank is reached. It is necessary to make the tanks level, but it is not necessary to locate them on tangents; the Philadelphia & Reading has a tank on a curve of two degrees; some of the railways in England do not hesitate to locate track tanks on curves. **Track tanks, sizes and lengths.**

In America the tank is usually made of steel plate 3-16-inch or ¼-inch thick, bent lengthwise to the shape of the tank, and having riveted to the outside upper edges rolled sections, such as channels or angles, and by means of these rolled sections the tanks are supported upon the cross-ties. There are in use on the Chicago, Milwaukee & St. Paul Railway two track tanks made up of cast-iron sections, each section being six feet long; the cross section of these tanks and the method of fastening the sections together are shown in Fig. 29, and the general arrangement of the tanks and of the piping are shown in Fig. 28. These cast-iron tanks do not rust out, not as rapidly, at least, as those made of plates. In England the tanks are made of sheet steel or iron, as shown in Figs. 33 and 34; in a few cases cast iron is used and the cross section of one of these and the manner of making the joints are shown in Fig. 40; each section is six feet long. In Fig. 40 is shown the tank used by the Lancashire & Yorkshire Railway. **Track tank material.**

The relative elevations of tank and of top of rail are governed by circumstances. In America the top edges of the sides of the tank are placed at about the same elevation as the top of the rail, the scoop on the tender is gauged from top of rail, and the lower end of the scoop has an extreme movement from a position three or four inches above top of rail to a position three or four inches below top of rail, the latter position for scooping **Elevation rai and tank.**

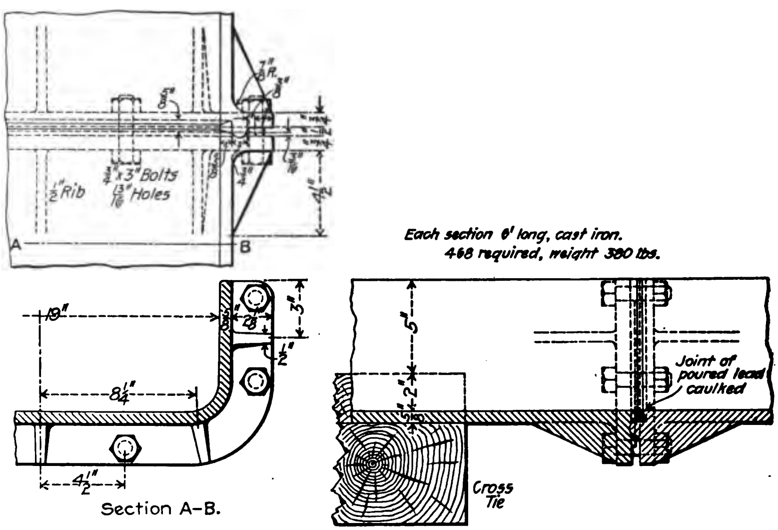

½" Rib
¾"x3" Bolts
13/16" Holes
A
B
Section A-B.
Each section 6' long, cast iron.
468 required, weight 380 lbs.
Joint of poured lead caulked
Cross Tie

FIG. 29.

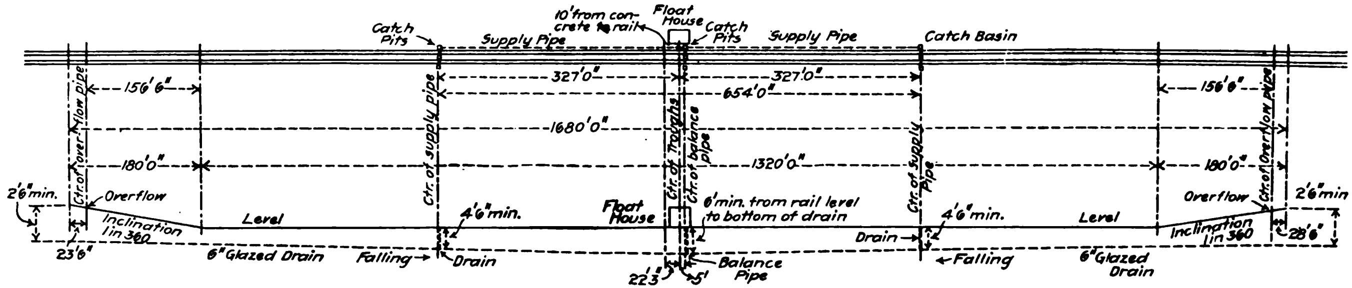
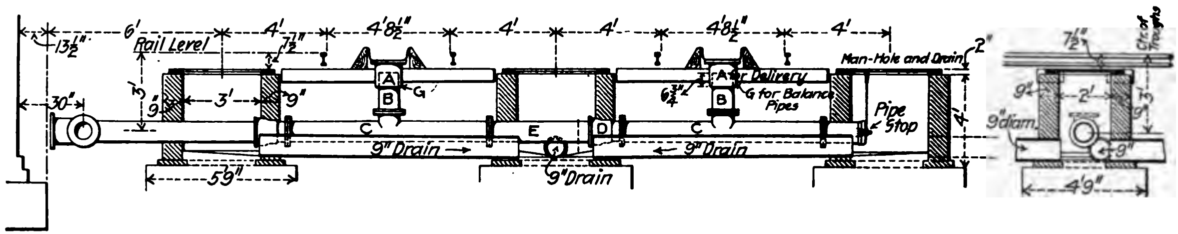


FIG. 30.



Delivery and Balance Pipes.

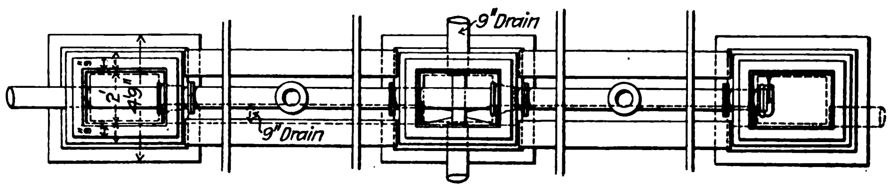


FIG. 31.

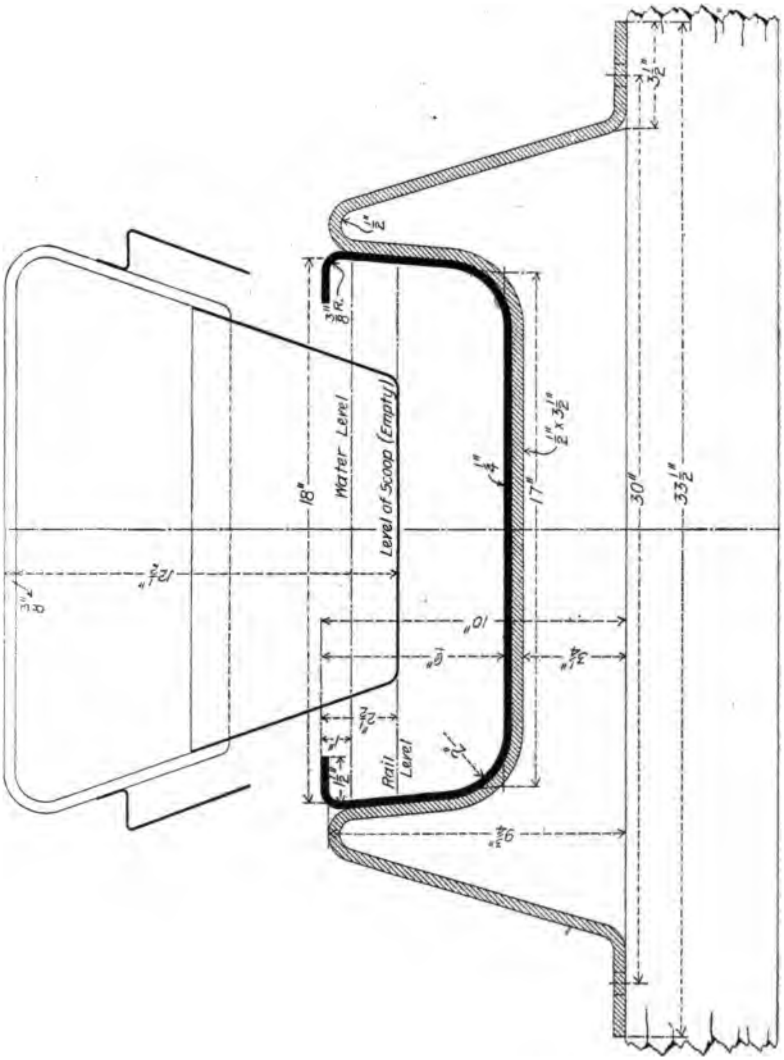


FIG. 33.

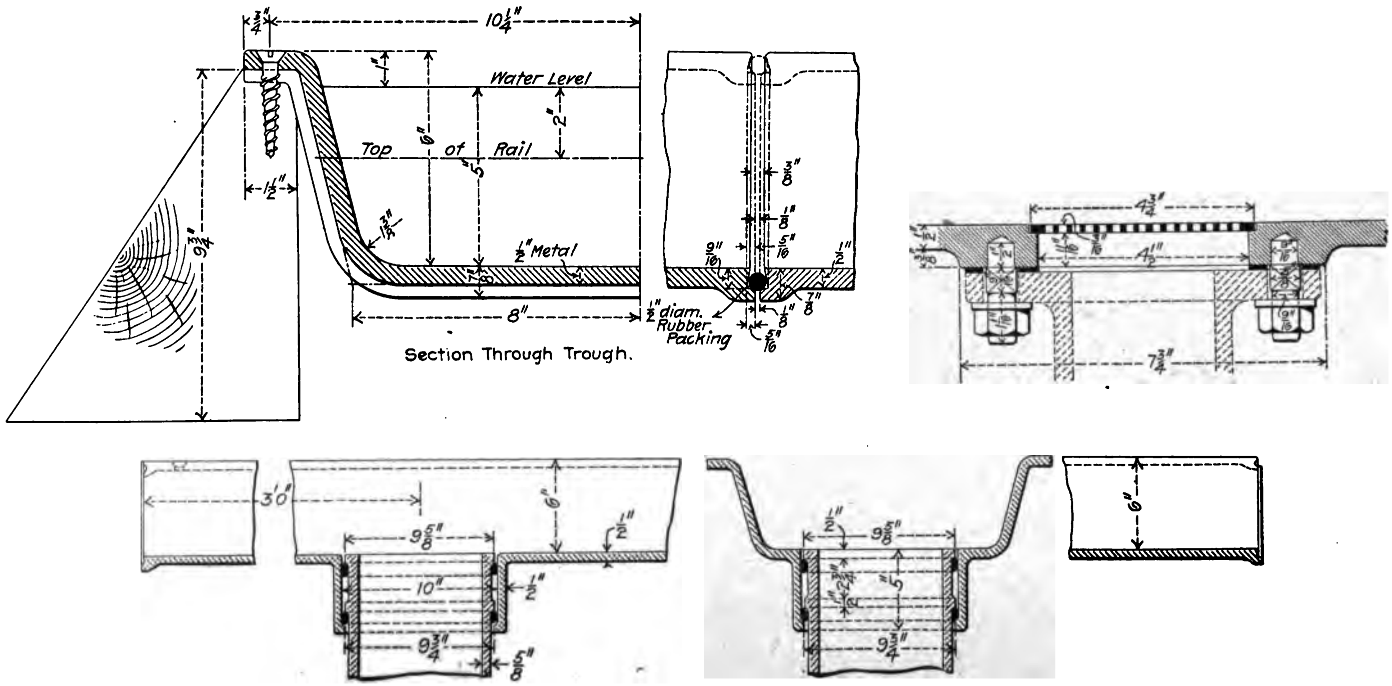

Water Level
Top of Rail
1/2" Metal
1/2" diam. Rubber Packing
Section Through Trough.

FIG. 40.

water. In England the relative elevations of tank and top of rail are not so uniform, on some railways the top of rail immediately at the tank is depressed six inches below the normal position, or to an elevation about two and one-half inches below the top of tank, this elevation being about one and one-half inches below the level of the water in the tank. The latter arrangement is clearly shown in Fig. 34. The change in elevation of the rail, six inches, is made in a distance of 180 feet. The illustration shows the cross section of the tank and the general arrangement of the tank as used on the London & Northwestern Railway, and, with a few slight differences, the illustration serves to show the construction used on the Great Eastern Railway, England. There are advantages to this arrangement; it is not necessary to operate the scoop through such extreme limits, but it would be best, probably, to have the arrangement such that the scoop would need to be dropped into the water, otherwise the scoop would clean out the water in the trough, whether or not it was desired to fill the locomotive tank, and the scoop would be dragged the full length of the trough, even though the locomotive tank were filled in a less distance. Conditions which prevail in America are such that it is not desirable to have anything between the rails which projects above the rails. The track tanks are secured to the cross-ties or to the stringers so that there will be no possibility of moving them from position.

A slope is provided at each end of the track tank so that if it happens that the scoop is not raised before the end of the tank is reached the scoop will ride up on the incline and be raised over the end of the trough. The scoop is arranged, usually, so that when raised as high as the top of the track tank it will be raised higher than the top of rail, even though the operator fails to do his part. Also, an incline is provided sometimes for the approach to the tank at each end, so that if the scoop is dropped too soon it will ride the incline into the trough. The construction of both inner and outer inclines as used in America is shown in Figs. 23, 25, 26 and 27. The slope usually provided is too abrupt; in England an easier slope is provided. Of course, it happens sometimes, when the raising of the scoop is dependent upon human energy, the raising is neglected or some of the machinery is out of order, and the end of the track tank is torn out; this difficulty is not particularly serious, but it is annoying; to facilitate repairs the lower end of the scoop is made in such a way as to be easily renewable, and the end of the track tank may be made of a piece of plank bolted to the tank. If the slope is twenty feet or twenty-five feet long the tank will be injured less frequently. Track tanks are not storage tanks; they must be refilled after each passage of a scoop through them. **End slopes**

Track tanks are supplied from reservoir tanks usually, and the size of pipe through which water is delivered to the track tank will be determined by the minimum length of time allowed to fill the track tank, and by the location of the inlets to the track tank. The gravity head to produce flow in the tank is not great; therefore, in order to increase the rate of flow, the distance through which the water must flow in the tank should be as short **Water supp to track tan**

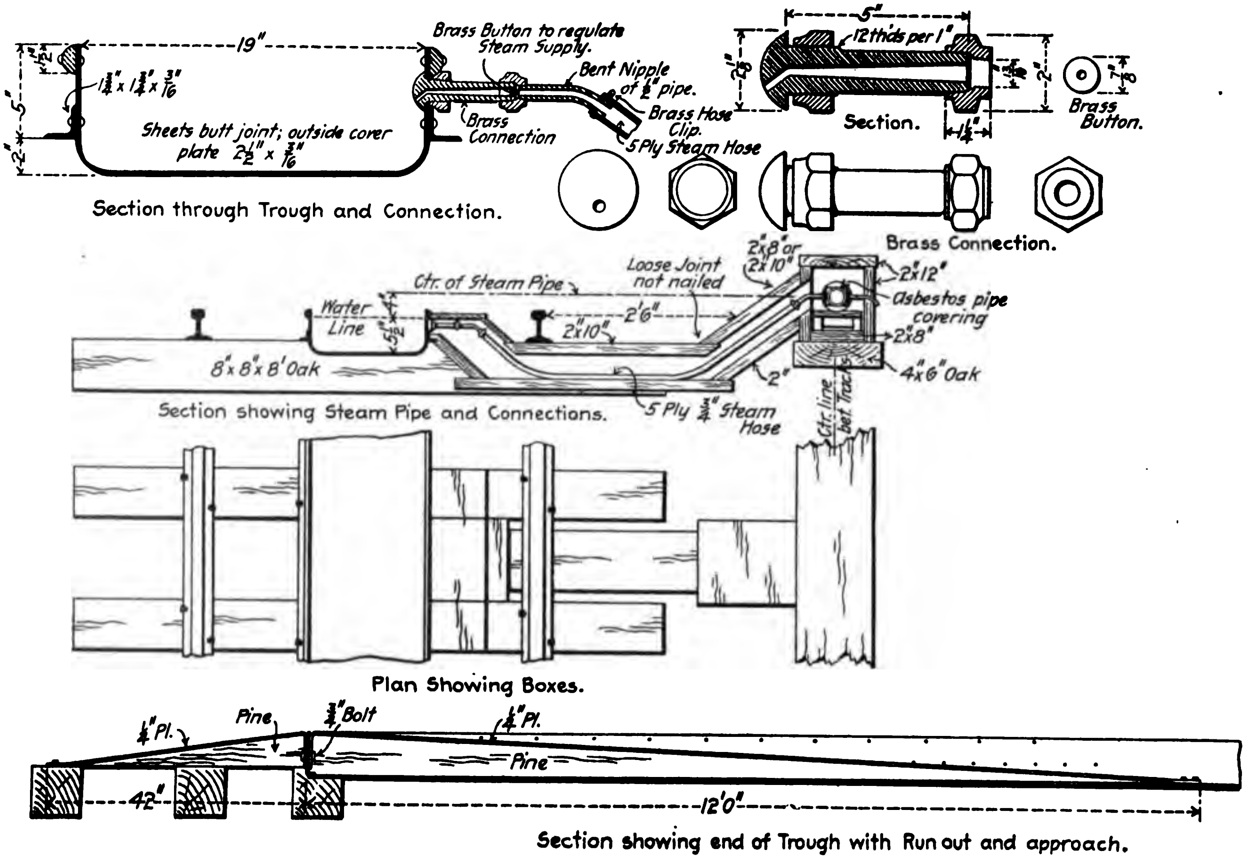
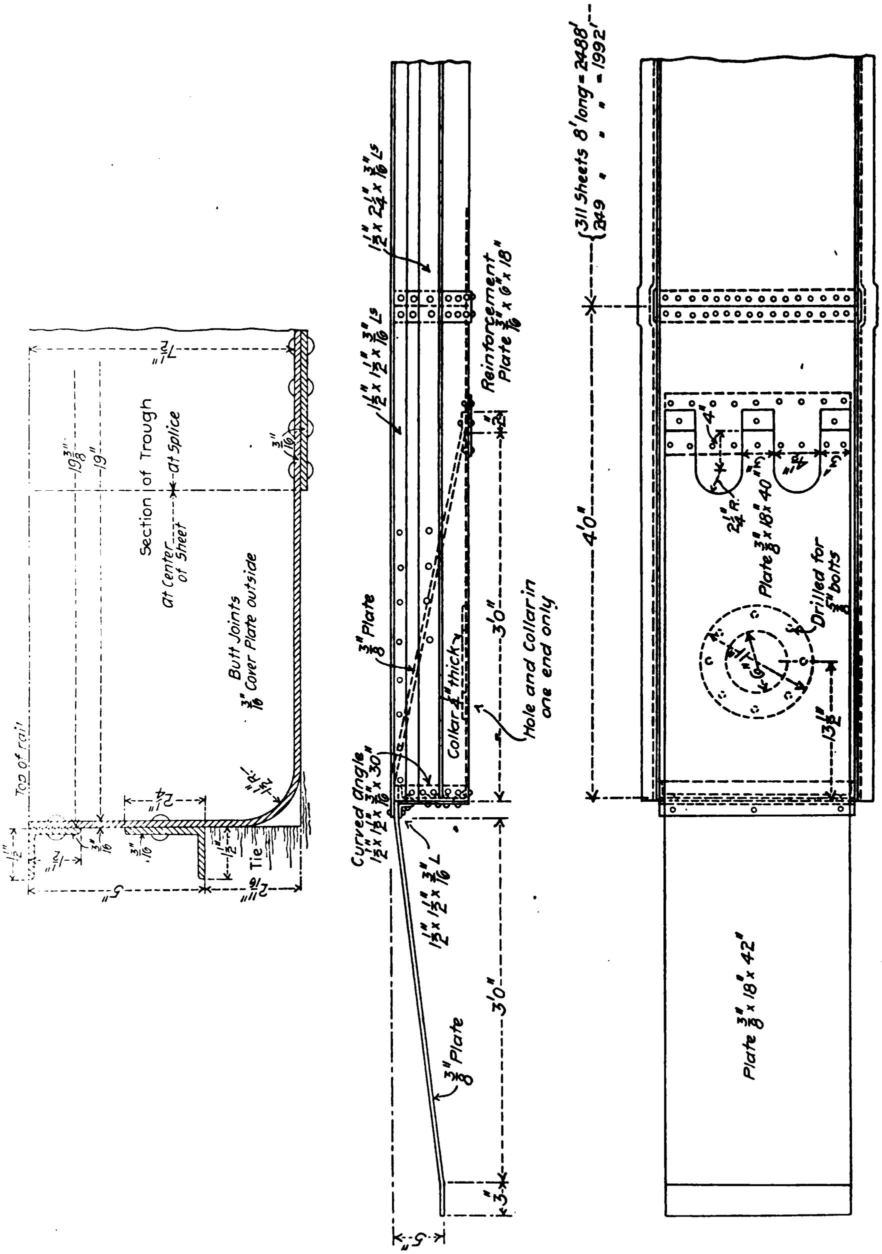

19"
Sheets butt joint; outside cover plate 2½" x 3/16"
Section through Trough and Connection.
Brass Button to regulate Steam Supply.
Bent Nipple of ½" pipe.
Brass Connection
Brass Hose Clip.
5 Ply Steam Hose
5"
12 thds per 1"
Section.
Brass Button.
Brass Connection.
Water Line
Ctr. of Steam Pipe
Loose Joint not nailed
2'6"
2"x10"
2"x8" or 2"x10"
2"x12"
Asbestos pipe covering
2"x8"
4"x6" Oak
8"x8"x8' Oak
Ctr. line bet. tracks
5 Ply ¾" Steam Hose
Section showing Steam Pipe and Connections.
Plan Showing Boxes.
¼" Pl.
Pine
¾" Bolt
Pine
42"
12'0"
Section showing end of Trough with Run out and approach.

FIG. 25.



Section of Trough
At Center of Sheet
at Splice
Butt Joints
3/16" Cover Plate outside
Top of rail
Tie
1 1/2" x 2 1/4" x 3/16" Ls
1 1/2" x 1 1/2" x 3/16" Ls
Reinforcement Plate 3/16" x 6" x 18"
3/8" Plate
Collar 1/4" thick
Hole and Collar in one end only
Curved Angle 1 1/2" x 1 1/2" x 3/16" x 30"
1 1/2" x 1 1/2" x 3/16" L
3/8" Plate
3'0"
3'0"
4'0"
311 Sheets 8' long = 2488'
249 " " " = 1992'
Plate 3/8" x 18" x 40"
Drilled for 5/8" bolts
Plate 3/8" x 18" x 42"

FIG. 26.

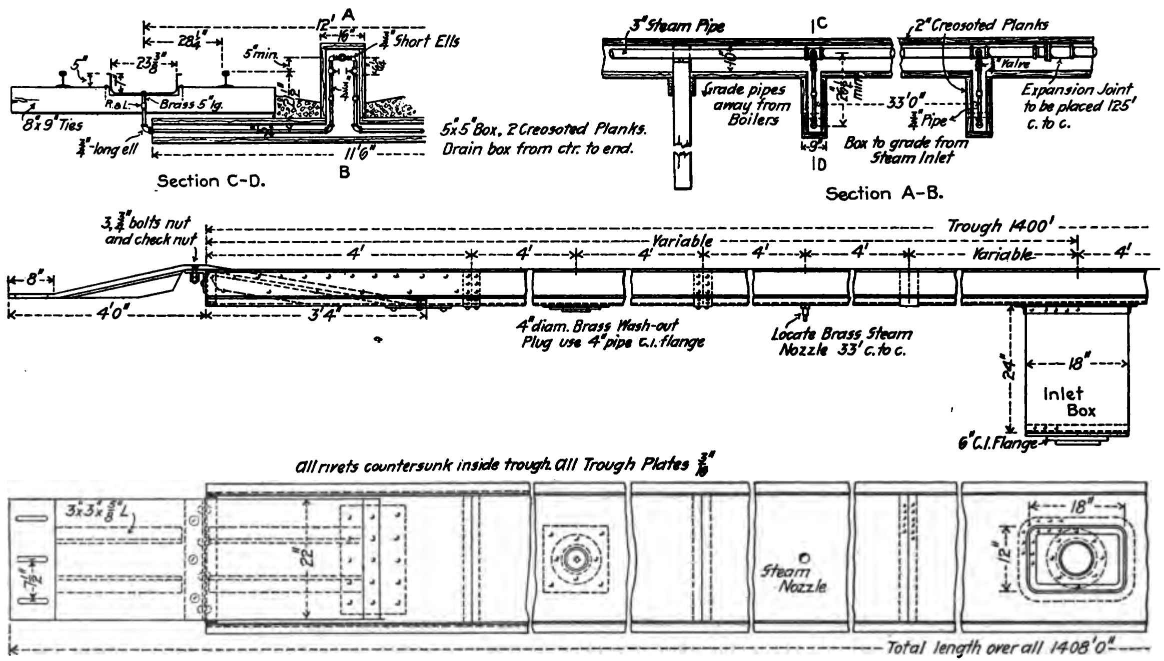

Section C-D.
12' A
16"
3/4" Short Ells
28 1/4"
23 3/8"
5" min.
5"
Brass 5" lg.
8"x9" Ties
3/4"-long ell
11'6"
B
5"x5" Box, 2 Creosoted Planks.
Drain box from ctr. to end.
3" Steam Pipe
C
D
2" Creosoted Planks
Valve
Grade pipes away from Boilers
33'0"
3/4" Pipe
9"
Box to grade from Steam Inlet
Expansion Joint to be placed 125' c. to c.
Section A-B.
3, 3/4" bolts nut and check nut
Trough 1400'
Variable
4'
8"
4'0"
3'4"
4" diam. Brass Wash-out Plug use 4" pipe C.I. flange
Locate Brass Steam Nozzle 33' c. to c.
24"
18"
Inlet Box
6" C.I. Flange
All rivets countersunk inside trough. All Trough Plates 3/16"
3x3x3/8" L
7 1/2"
22"
Steam Nozzle
12"
Total length over all 1408'0"

FIG. 27.

as the demands require and circumstances will allow. The rate of flow in the tank can not be assisted by pressure, but it can be assisted by velocity if the stream is directed into the tank properly. For instance, if the inlet is in the end of the tank and the water is directed lengthwise of the tank, then the water may be forced into the tank at considerable velocity, and so reduce the time of flow to the opposite end of the tank; on the other hand, if the water is admitted vertically through the bottom of the tank the water must be run in slowly enough to prevent overflowing the sides. The bottom inlet may be used and the water be admitted at a considerable velocity by placing a deflector at the inlet so that a part of the water will be directed toward one end of the tank and the remainder be directed toward the other end. The bottom inlet is the usual one, and this is covered with a grating to keep out heavy, solid substances. Disregarding any possible velocity head, the location of the inlet, or inlets, for most rapid filling will be understood readily from the following explanation: If the tank is 1,600 feet long and 7 inches deep, and the one inlet located at one end the maximum gravity head is, of course, 7 inches in 1,600 feet, and frequently this is overcome by a strong wind blowing in a direction opposite to the flow; if the inlet is placed at the middle of the length, the maximum gravity head is 7 inches in 800 feet; with two inlets each should be placed at a distance from each end of the tank equal to one-quarter the length of the tank. If there is to be only one inlet for each tank and this one located at the end of the tank, the approach end should be preferred. If the water is to be kept from freezing by circulating it through the tanks and through injectors or other heater, the relative locations of inlets and outlets will be such that there will be no "short circuiting" of the heated water, and therefore no "dead ends" in the tanks. The general practice in America is to control the flow of water into the tanks by means of a valve operated by the attendant at the pump house. Immediately after a scoop has been run through the tank the attendant opens the valve through which is controlled the flow of water into that tank and he closes the valve again when the tank is filled. Sometimes an annunciator is placed in the pump house to give warning when the tank is filled, and sometimes the attendant must go to the tank and see when it is full. At other times the attendant opens the valve a certain amount and leaves it open for a certain length of time, and then closes the valve. All of these uncertain conditions make possible, between engine crews and pump attendants, disputes concerning the amount of water in tanks at various times. A more positive, automatic arrangement is used in England, the controlling valve being operated by means of a large float, the float being in a tank of water which is connected to the track tank by an equalizing pipe. The automatic control, as used on the Great Northern Railway, of England, is shown in Fig. 41; that on the Great Western is shown in Fig. 32. Drawings of the Great Western Railway devices were received from Mr. William Dean, who has charge of the locomotive and carriage department; the drawings were sent by Mr. G. J. Churchward. The automatic control, as used on the Great Eastern, is

Location of inlets.

Control of water to tan

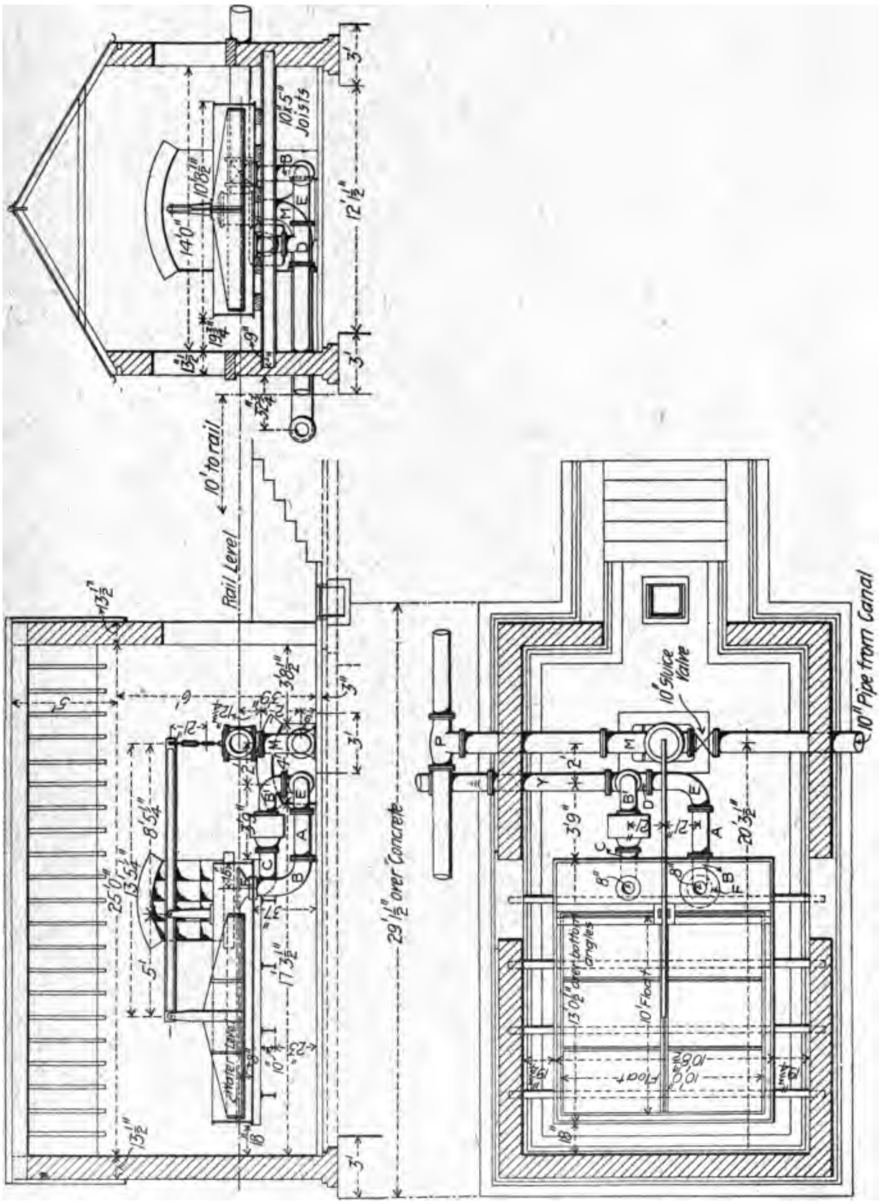

10' to rail
Rail Level
29'1½" over Concrete
10" Sluice Valve
10" Pipe from Canal
10" Float
13'0½" over bottom angles
Joists

FIG 32.

shown in Figs. 36 and 37, and the connection between filling pipe and tank in Fig. 38. Some idea of the dimensions of the floats, float tanks, pipes, etc., will be gained best by reference to Fig. 32.

Heating wa in track tan

When track tanks are in use in climates sufficiently cold to freeze the water, provision must be made to keep the water above the freezing temperature, or the tanks must be put out of service during the winter. Sometimes the latter alternative is accepted, and this is a very quick way to dispose of the track-tank question. One of two means may be used to prevent ice forming in the tanks; steam may be blown into the water in the tanks, or the water may be circulated by means of an injector and so heated, or by a pump delivering the water through a heater. The Philadelphia & Reading admit steam to the tank through the bottom of the tank, as shown in considerable detail in Fig. 24. A quite similar method is used on the New York Central & Hudson River Railroad. The steam inlets are placed thirty feet apart in the Philadelphia & Reading tank. The Lake Shore & Michigan Southern prefer to locate the steam inlets in the vertical sides of the tank; the explanation for this preference is given by Mr. Sam Rockwell, principal assistant engineer, that the water from the tank can not flow by gravitation into the steam-pipe, and there is not the necessity of maintaining a pressure of steam sufficient to force the water from the steam-pipe. The steam connection used on the Michigan Central Railroad is shown in Fig. 25; the connection is made at the side of the tank. The Chicago, Milwaukee & St. Paul Railway use the circulating system, circulating the water through the tanks and a heater by means of a pump; the general arrangement, in more or less detail, is shown in Fig. 28. The Pennsylvania Railroad uses a circulating system, the heating and circulating being done by means of a No. 9 ejector for two tanks about twelve hundred feet long; the general arrangement is shown in Fig. 22. By manipulation of the valves shown in enlarged elevation near plan of pump house, Fig. 22, either track tank can be filled independently, both can be filled at the same time, the water in either track tank can be circulated, and either track tank can be washed out. Means for washing out track tanks are sometimes neglected. The circulating and the water-pipe lines in the Pennsylvania Railroad layout are laid in the same box, box made of 1½-inch hemlock and filled with puddled clay.

The heating system used on the Lancashire & Yorkshire Railway, England, is shown very clearly in Fig. 39. Drawings from which the cut was made were received from Mr. H. A. Hoy, and they were the only evidence received that showed that heating the water is necessary in England; heating the water may be more general there than this evidence would indicate.

The New York. New Haven & Hartford Railroad uses tanks made of steel plate; the two inlets for water are placed about one-quarter the length of the tank from each end of the tank.

Description of the track tanks used on the Baltimore & Ohio was given in the proceedings of the Association of Superintendents of Bridges and Buildings, and it is thought to be unnecessary to repeat the description here

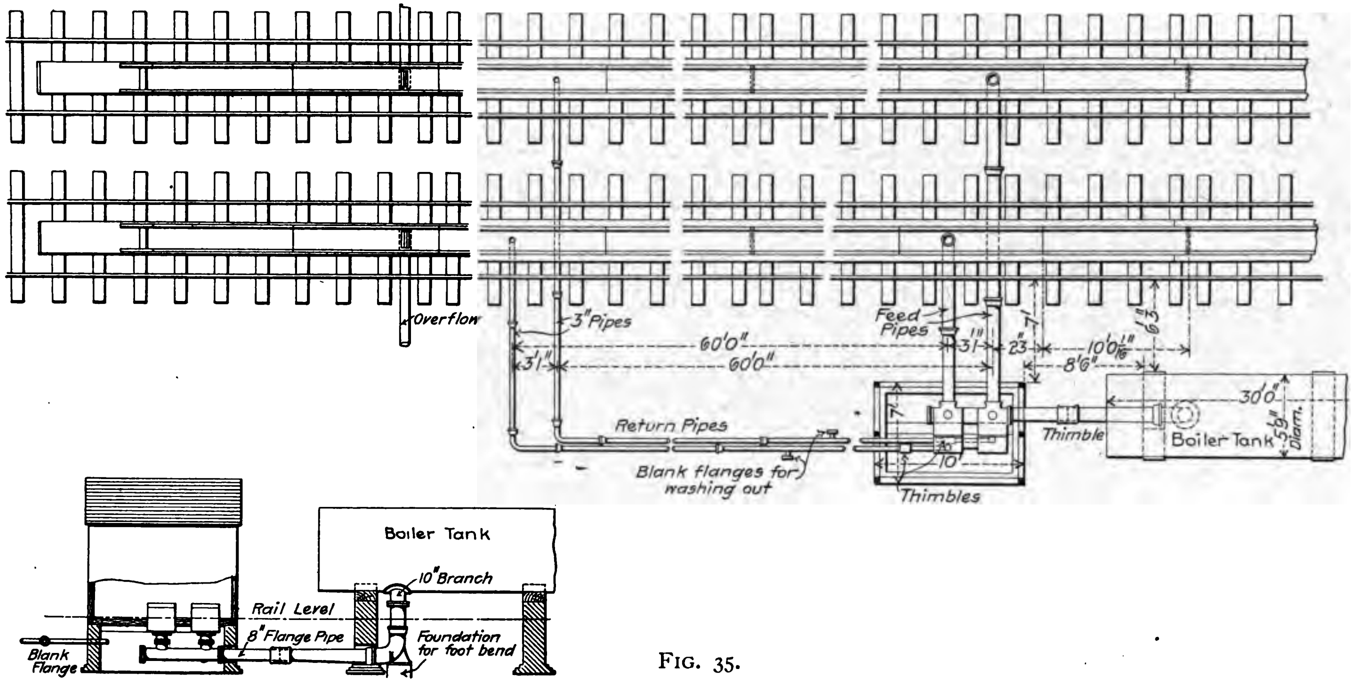

Overflow
3" Pipes
Feed Pipes
60'0"
60'0"
3'1"
3'1"
23"
7'
10'0 1/16"
8'6"
6'3"
30'0"
5'9" Diam.
Boiler Tank
Thimble
Return Pipes
Blank flanges for washing out
7'
10'
Thimbles
Boiler Tank
10" Branch
Rail Level
8" Flange Pipe
Foundation for foot bend
Blank Flange

FIG. 35.

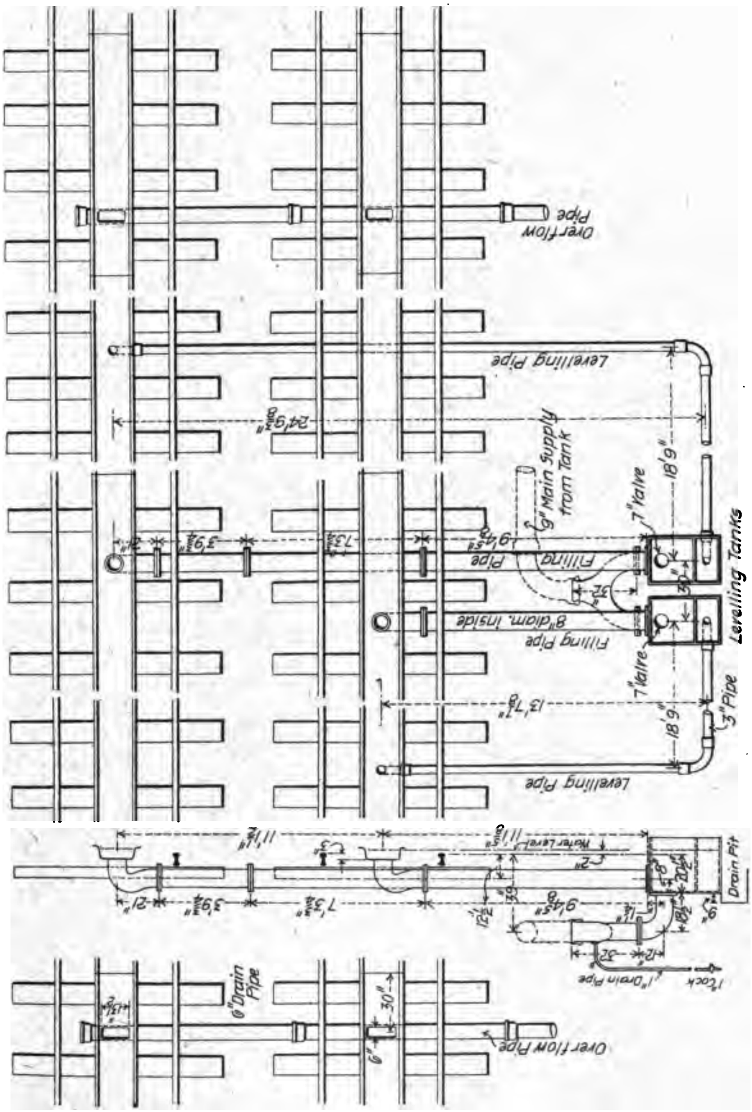

Overflow Pipe
Levelling Pipe
9" Main Supply from Tank
7" Valve
Filling Pipe
8" diam. inside
Filling Pipe
7" Valve
3" Pipe
Levelling Pipe
Levelling Tanks
Water Level
Drain Pit
6" Drain Pipe
1" Drain Pipe
1" Cock
Over flow Pipe

FIG. 36.

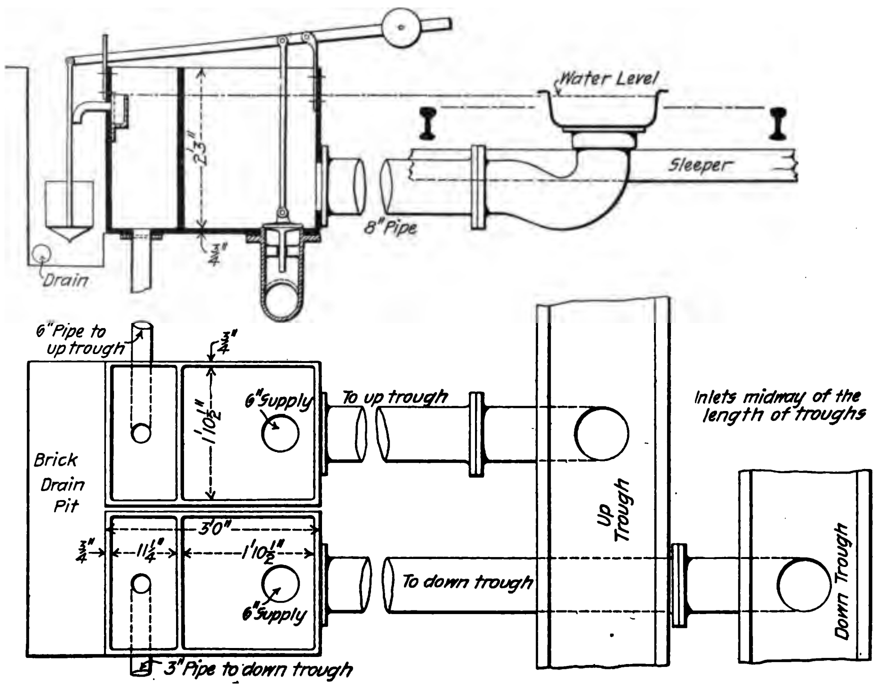

Water Level
Sleeper
8" Pipe
Drain
2'3"
6" Pipe to up trough
6" Supply
To up trough
Brick Drain Pit
Inlets midway of the length of troughs
3'0"
1'10½"
11¼"
To down trough
Up Trough
Down Trough
3" Pipe to down trough

FIG. 37.

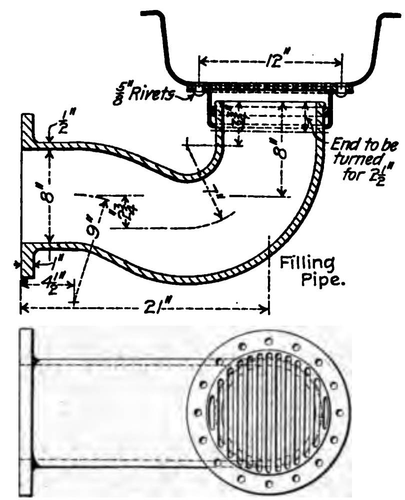

12"
⅝" Rivets
End to be turned for 2½"
8"
7"
9"
21"
4½"
Filling Pipe.

FIG. 38.

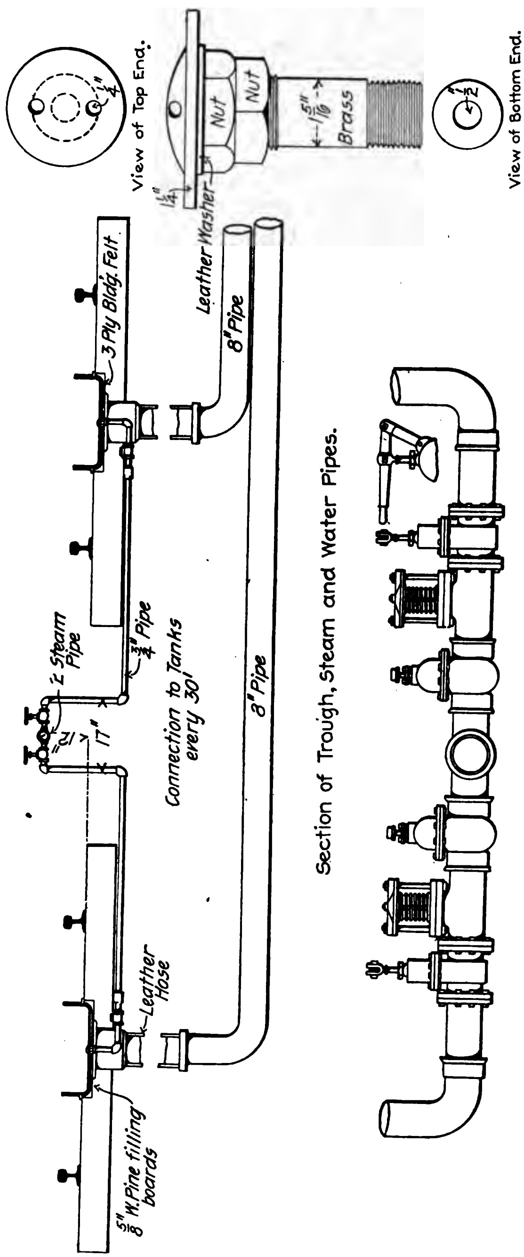

View of Top End.
1/4"
Nut
Nut
1 5/16"
Brass
1/4"
Washer
View of Bottom End.
1/2
Steam Jet.
3 Ply Bldg. Felt
Leather Washer
8" Pipe
2" Steam Pipe
3/4" Pipe
12"
17"
Connection to Tanks every 30'
8" Pipe
Leather Hose
5/8" W. Pine filling boards
Section of Trough, Steam and Water Pipes.

FIG. 24.

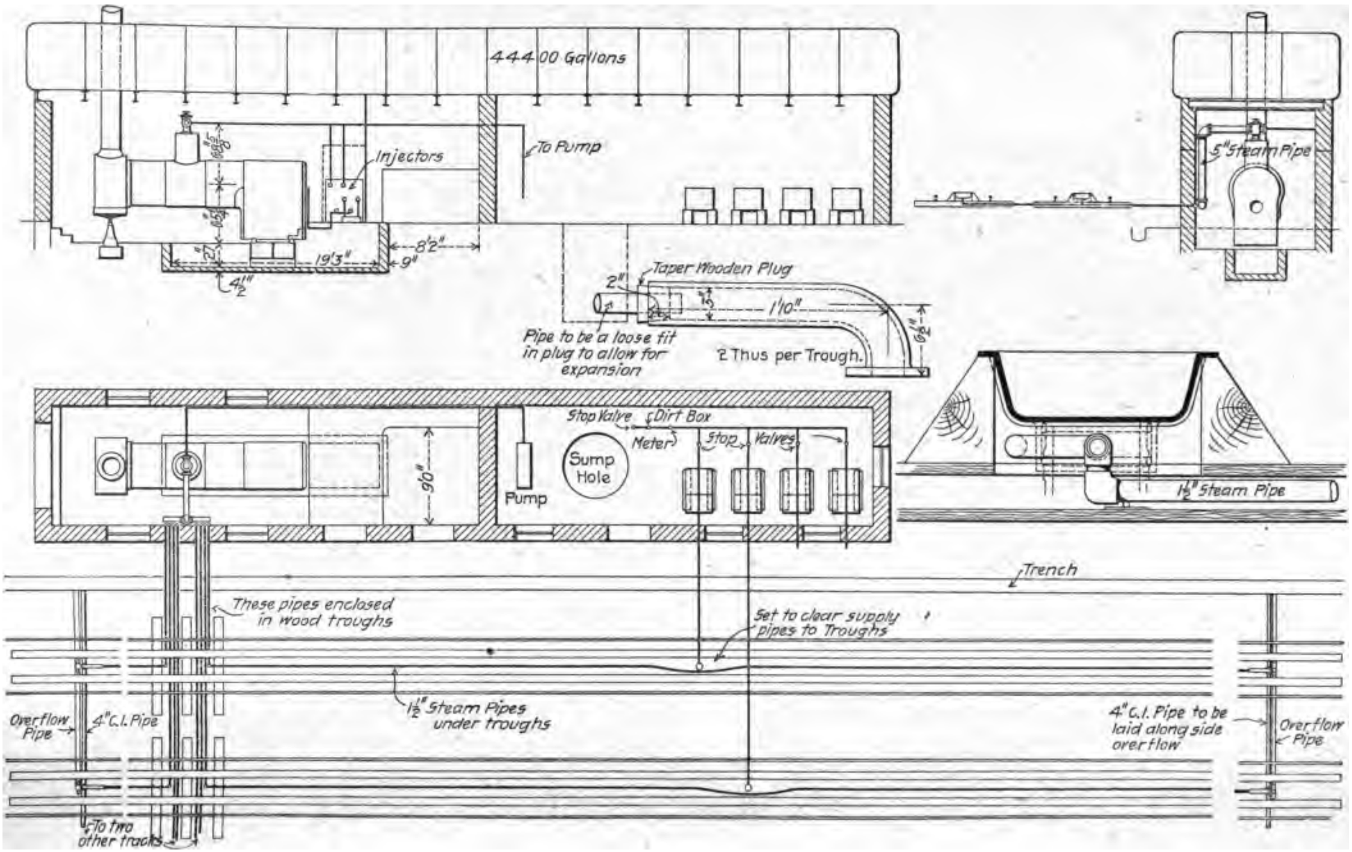

44400 Gallons
To Pump
Injectors
8'2"
9"
19'3"
4½"
5' Steam Pipe
Taper Wooden Plug
2"
1'10"
Pipe to be a loose fit in plug to allow for expansion
2 Thus per Trough.
Stop Valve
Dirt Box
Meter
Stop
Valves
Sump Hole
Pump
9'0"
1½" Steam Pipe
Trench
These pipes enclosed in wood troughs
Set to clear supply pipes to Troughs
1½" Steam Pipes under troughs
Overflow Pipe
4" C.I. Pipe
To two other tracks
4" C.I. Pipe to be laid along side overflow
Overflow Pipe

FIG. 39.

The Central Railroad Company of New Jersey are using track tanks of the usual construction.

Drainage at track tank

Proper drainage in the vicinity of a track tank is a serious problem, and any descriptive treatment of it should be prepared by some person who is more familiar with it than the writer of this paper. There is a considerable volume of water to be taken care of, if the water is scooped frequently, because so much water is splashed by the scoop. If the water is scarce the spill can be drained back to the pump. Scoops which are so designed that only thin edges of metal are in contact with the water produce less waste, but even these spill a considerable amount. Mold boards might be provided on the sides of the scoop, and by this means much of the water which otherwise would be spilled would be returned to the tank; the top edges of the tank might be turned inward slightly with good results. The only evidence that these precautions to lessen the spill have been taken is shown in Fig. 33; it will be seen that the top edges of the tank are turned inward a width of 1½ inches, and that there is a shield on each side of the scoop. Fig. 33 shows the relation of tank and scoop on the Great Western Railway, of England. The writer is not informed of the object of these peculiarities, but the presumption is that their use will lessen the spill. When dependence is placed on the watchfulness of the attendant to close the filling valve when the tank is full it is quite certain to occur that the water will be allowed to overflow the tank frequently; the float control would reduce this waste materially. Overflow outlets are sometimes provided, and when such provision is made, disposal of the overflow water is more easily made.

Connections between track tanks and pipes.

The connections between pipe lines and tanks need careful consideration; they change in relative length with changes in temperature, and the frost affects the vertical position of the tanks more than it does position of the pipes, therefore flexible connections are necessary. A short piece of leather or of rubber hose is used sometimes, and the illustrations show other connections.

VIII.

WATER SCOOPS.

History of water scoop

A little history may prove as interesting to the members as it did to the writer: Mr. F. W. Webb, chief mechanical engineer of the London & Northwestern Railway, wrote that water scoops and track tanks were first introduced on that railway in 1857. Mr. Webb was engaged in putting the first one to work. The London & Northwestern is supplied with track tanks all over the system, and it is seldom that water is delivered to the locomotive tank from water columns. It was not attempted to gather history, and possibly the use of water scoops in America antedates the use of them on the New York Central & Hudson River Railroad, but it is worth mentioning that in 1870 Mr. William Buchanan designed for the New York Central a water scoop, which was then designated "a jerk water";

the scoop was placed back of the rear truck of the tender, and the pipe leading to the tender tank was back of, and outside of, the tender tank.

y of scoops.

A mathematical treatment of the theory of water scoops was prepared by Prof. I. P. Church, of Cornell University, and publication was made in Volume 75, page 376, of the *American Engineer and Railroad Journal;* a summary only is given here:

If h = height, in feet, to which the water is to be raised;
c = velocity of scoop, in feet, per second;
c'' = velocity of the water at highest point to which the water is raised (feet per second);
g = 32.2 (being the acceleration of gravity);
m = loss of head due to friction in scoop and conveying pipe (to be determined for each design of scoop);
q = quantity of water raised per second, cubic feet;
m' = 0.10 to 0.50;
f = area of scoop at mouth, square feet;
f'' = area of pipe at top, square feet;

Then,
$$h = \frac{c^2}{2g} - \frac{c''^2}{2g} - \frac{m}{2} \times \frac{c^2+c''^2}{2g}$$
$q = fc.$

If h, c and f are known c'' becomes known from the equation, $fc = f''c''$, and its value may be compared with the area exposed to the water in the trough. Either the size of the pipe at the top, or the area of scoop exposed to water in the tank, may limit the amount of flow. The area of the scoop exposed to water should be less than the area of the pipe above, because of the reduction in velocity above the intake. For pipe closed above the inlet the equation is:
$$c = \frac{\sqrt{2gh}}{\sqrt{1 - [m' + \left(\frac{f}{f''}\right)^2}}$$

r designs ›ps.

There is shown in Fig. 42 the scoop used on the Baltimore & Ohio. A much similar arrangement is used on the Philadelphia & Reading and on the Chicago, Milwaukee & St. Paul Railway. The Baltimore & Ohio scoop is being changed. This arrangement was used in America very generally until within a year or two, and during the later period several new scoops have been designed. The Baltimore & Ohio scoop is operated by means of a lever which is located in the gangway between tender and engine. The scoop is lowered against the compression of the spring in the case marked "A"; this spring counterbalances the weight of the pivoted part. The hood over the inlet to the scoop is put on so that the water striking against it will assist in raising the scoop from the water, because at high speeds a considerable force is needed to raise the scoop. This form of inlet produces considerable splashing, and in later designs of scoops this objection has been corrected by presenting to the water only the edges of the sides

and bottom walls of the intake. The shield in front of the scoop in the raised position is provided to keep out ballast, etc. In cold climates the scoops must be kept free from ice, and to this end steam is directed against those parts which are likely to be frozen; steam is directed to the trunnions of the scoop and to the inlet end. The exhaust from the air pumps might be utilized for this purpose. To prevent lowering the scoop far enough to come into contact with the bottom of the track tank, a positive stop is pro-

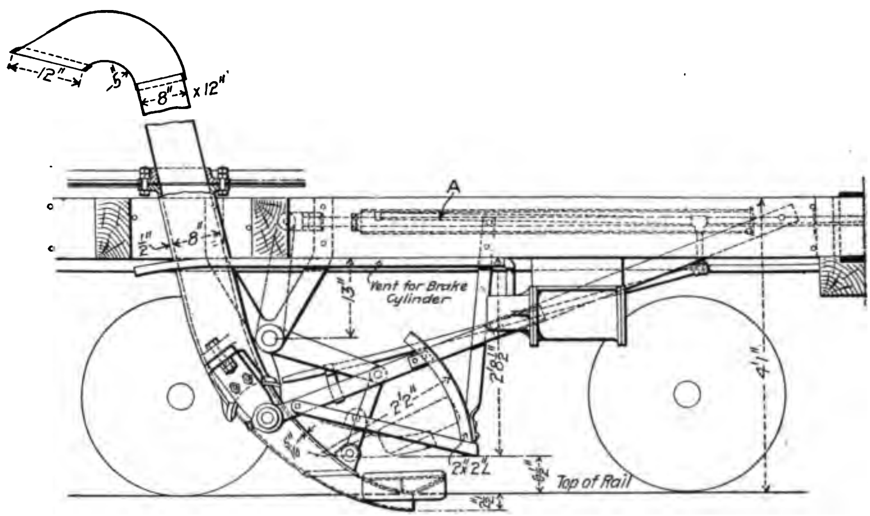


FIG. 42.

vided, which can be adjusted; this stop is illustrated clearly in Figs. 43 and 44. Sometimes carrying wheels have been attached to the lower end of the scoop, these wheels to carry the scoop when the lower end of the scoop is lowered dangerously near to the bottom of the track tank; the wheels are not used as much as formerly because rust forms in the bearings and the wheels can not revolve then.

Later designs of scoops. The first important departure from the scoop shown in Fig. 42, was made by the Pennsylvania Railroad, when they designed the balanced scoop shown in Fig. 43. The explanation of this balanced scoop is that the part which is rotated is pivoted in such a place that the water striking the back end, back of the pivot, counteracts the opposite effect of the water at the inlet end of the scoop. This scoop is patented. The provisions made for preventing parts of the scoop and of the air-brake equipment from being made inoperative by ice is shown in this engraving; U is a ¾-inch steam-supply pipe, V is ⅜-inch pipe to air cylinder, W is ½-inch pipe to scoop spring, X is ⅜-inch pipe to scoop hinge, Y is a ⅜-inch pipe to scoop guide, and Z is a ½-inch pipe to the spring. Frequently water is drawn into the

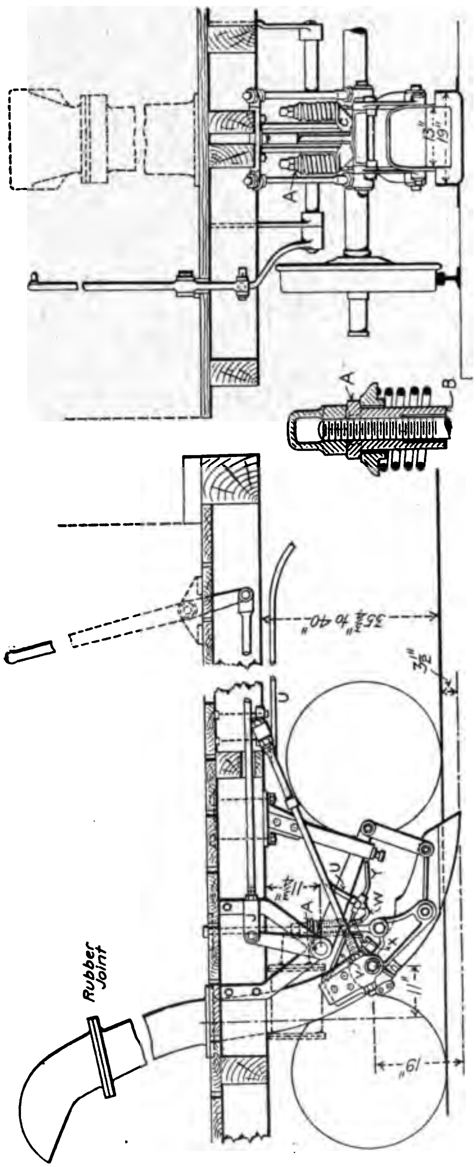


FIG. 43.

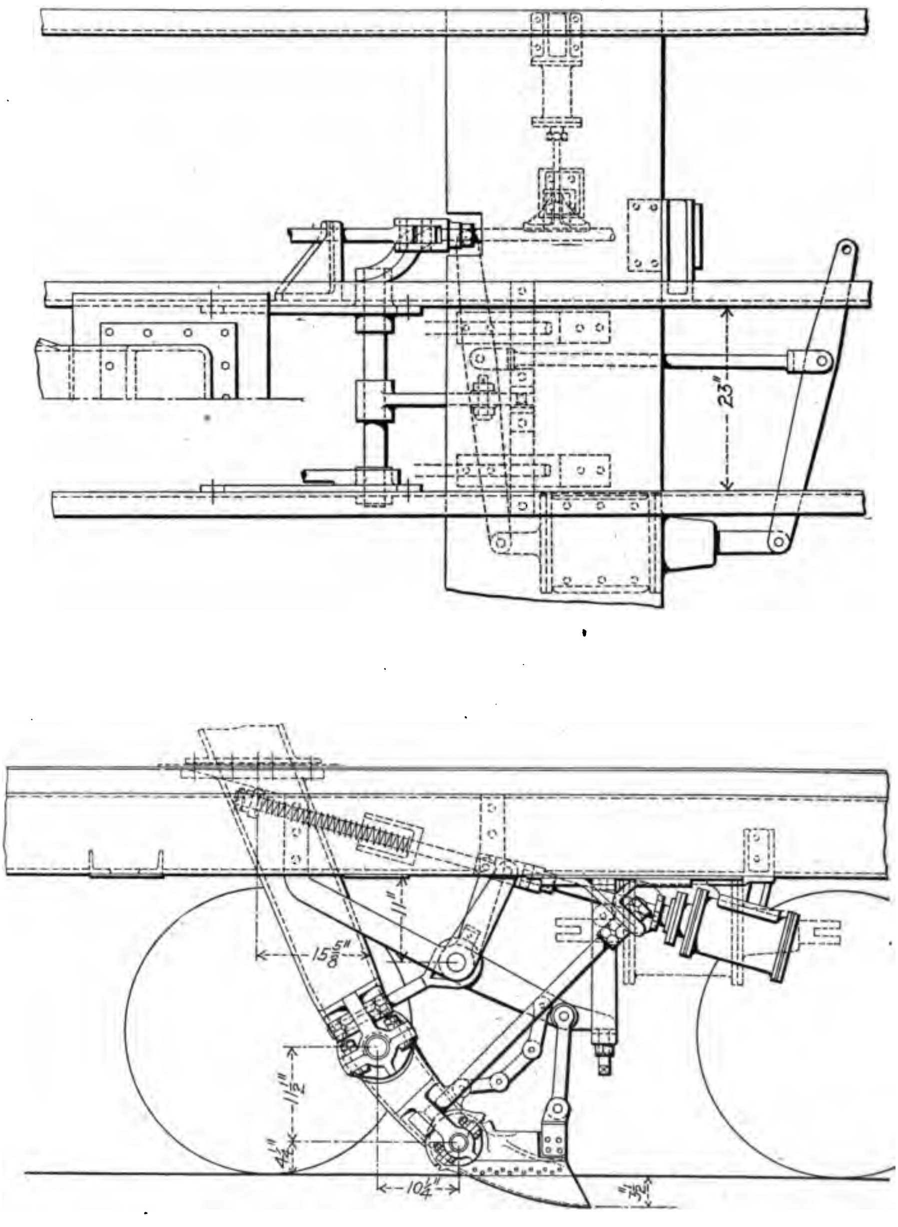


FIG. 44.

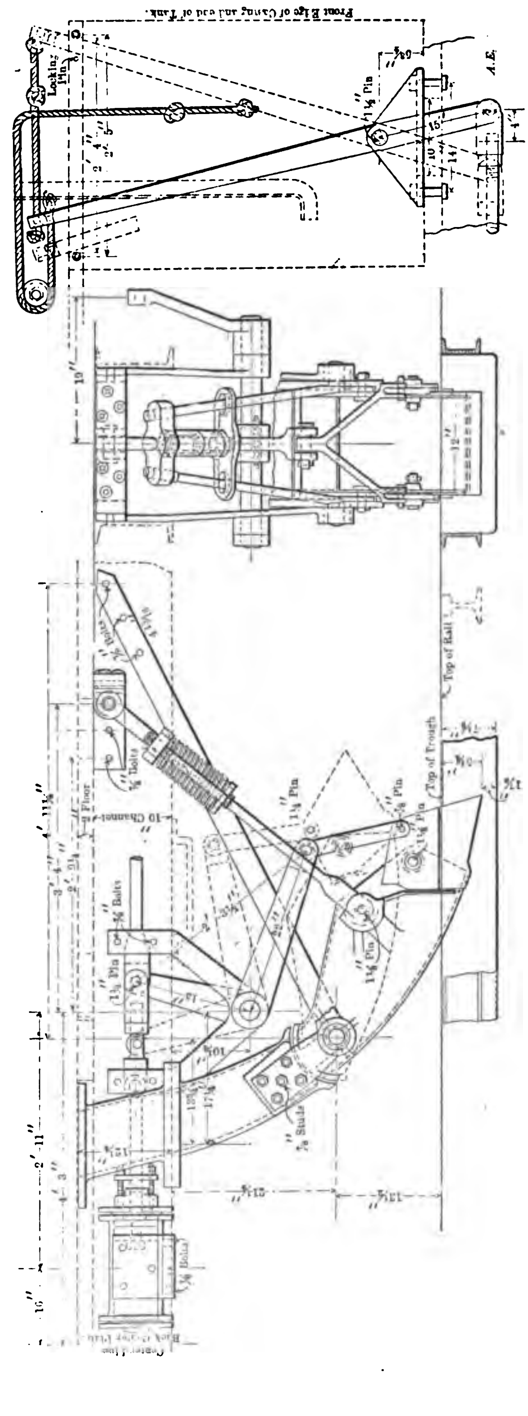


FIG. 45.

brake cylinder and into the triple valve, and much annoyance is experienced if provision against it is not made.

Two-section scoops, air operated.

More recently there have been designed several scoops with two pivoted sections, the lower one being short, so that it is tipped out of the water easily. Such a scoop is shown in Fig. 44, the illustration showing a scoop designed by Mr. F. H. Ball, superintendent of motive power of the Lake Shore & Michigan Southern Railway. The same design of scoop is used on the Central Railroad of New Jersey. A scoop in which is used the same idea of two sections is shown in Fig. 45; this scoop was developed on the New York Central & Hudson River Railroad, and the same is used on the Michigan Central Railway and on other railroads. The scoops shown in Figs. 44 and 45 are operated by compressed air, the latter being operative also by hand. The method of lifting the scoop shown in Fig. 44 is that the link attached to the outer end tips the outer end first and raises the scoop part way before the other link connection comes into play, then the movement is completed with the lifting being done through the inner link, the outer link becoming loose. The reverse is the case when the scoop is dropped. The stop for the lowest position is shown as engaging a continuation of the bell-crank arm. The adjusting screw and nut provide a means of changing the lowest position of the scoop. The scoop is locked

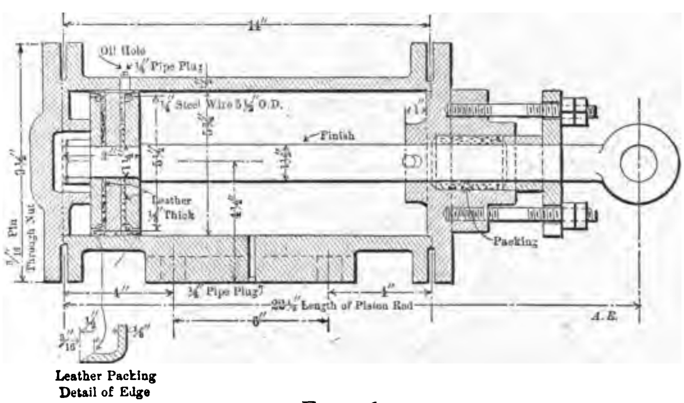


FIG. 46.

in the raised position by a piston which is forced outward by a coiled spring, the air for raising the scoop passes through this locking cylinder and forces the piston back against the spring and releases the lock, the air passing thence to the operating cylinder. Mr. Ball advises that the operation of raising or of lowering the scoop is almost instantaneous. The air is controlled by a valve located in the gangway.

In the design shown, Fig. 45, there is only one link attached to the scoop; this connection is made to the outer section, and when the outer section is raised a short distance it comes into contact with stops on the

other section and both are raised together. When the shorter section is turned above the horizontal position the force of the water assists the raising, and it is not difficult to tip up the short section. The coiled springs are compressed when the scoop is thrown down, and they will support the scoop above the top of rail if the scoop is thrown out of the water by the incline at the end of the track tank, or if the locking in the raised position is not secure. This scoop is locked up by means of a pin placed back of the hand-operating lever. The scoop can be operated by compressed air, and the cylinder provided for this is shown in Fig. 46. The controlling valve is located in the gangway.

nt in scoop
e.

It is not necessary to make a closely fitting joint between the pivoted section of the scoop and the fixed portion; the opening may be as wide as one-half inch, providing the edges of the fixed part do not project inside the edges of the pivoted part; therefore just a rough finishing of the adjacent surfaces of the castings is necessary.

e in
omotive
k.

The pipe inside the locomotive tank may be made entirely of cast iron, or there may be only a cast iron flange at the bottom, and to this be attached to a pipe made of plate material.

ns used in
ind.

Unfortunately, in writing to the railway men of England, the scoop was overlooked, and this neglect explains the incomplete showing of the designs used there; however, Mr. H. A. Ivatt was kind enough to send drawings of a scoop, and the drawings are reproduced in Fig. 48. The

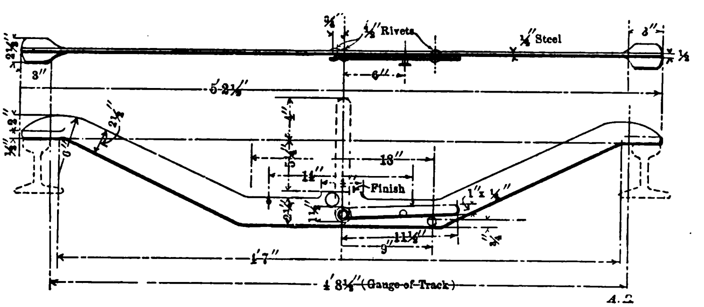


FIG. 47.

peculiarity of the design is the use of the cylinder at the back of the uptake pipe. The projection on the inside, back face of the pipe deflects water into the cylinder, and the pressure thus provided in the cylinder assists in raising the scoop. The scoop is otherwise raised by hand lever, by means of which a toggle is operated; the lowering is done entirely by hand by manipulating the lever and toggle. The pressure in the cylinder varies with the velocity of the water raised, so that the assistance from the cylinder is greatest when needed most. The flat lever is passed directly through the front wall of the uptake pipe, but no packing is required, because the water passes up at the back of the pipe, and none is spilled out through the

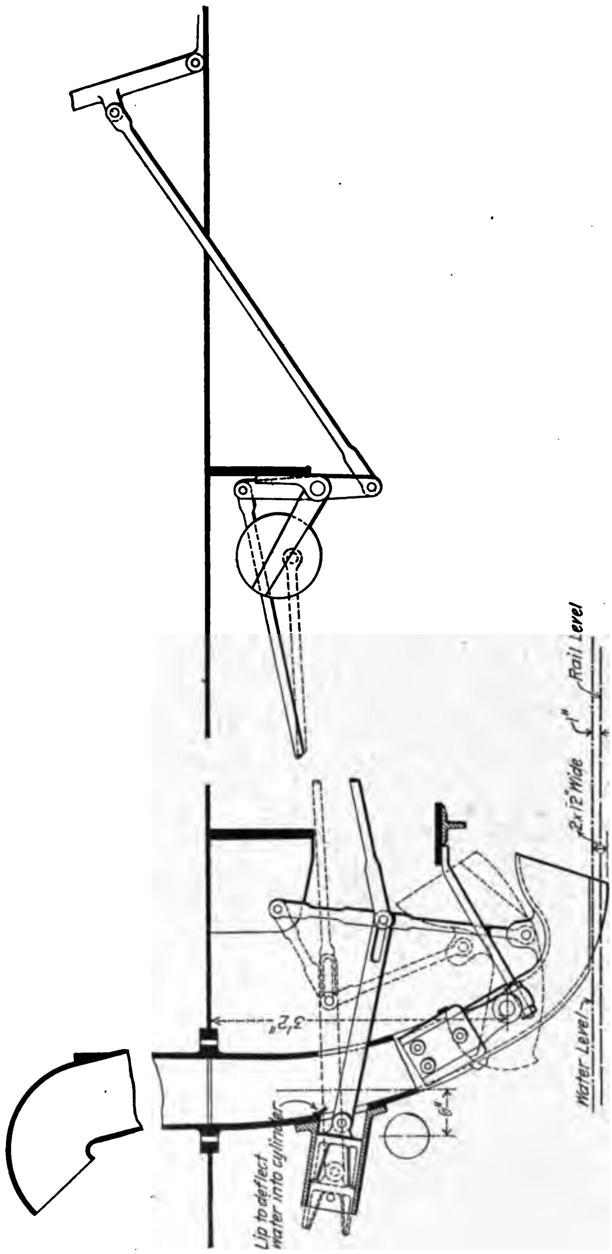

Lip to deflect water into cylinder
3'2"
6"
Water Level
2x12" Wide
1"
Rail Level

FIG. 48.

opening in the front. If the scoop is not lifted by hand the balance weight returns it to the "out" position, and keeps it there when clear of the water. The use of this cylinder is patented in England.

Gauging scoops.

It is important that the height of the scoops be gauged frequently, to insure that they can not be dropped low enough to strike the bottom of the track tank, and to insure that they can be dropped into the water; the difference between the limits is small, and when it is considered that the height of scoops is varied by the action of the truck springs, wear of journals, bearings and other parts, the importance of the watchfulness is apparent. On some railroads it is required that the scoops on locomotives hauling important trains be inspected every day, and, generally, the scoops should be inspected and the bearings lubricated sufficiently often to insure positive working. A gauge designed for this purpose is shown in Fig. 47; it is designed for gauging the scoop in the "down" position and in the "up" position. The method of using it will be readily understood.

General use of track tanks and scoops.

The importance of supplying water to locomotive tanks while the locomotive is in motion is being more generally appreciated, and those railroads which have been placing scoops on only passenger locomotives are now equipping freight locomotives with scoops; the saving in time and in wear and tear of rolling equipment when traffic is heavy is considered sufficient to more than offset the expense of track tanks and scoops.

Much more of detail might have been given, but the subject is so broad that the limits of a paper allow only some general directions for those who choose to search for the details.

The writer acknowledges the assistance of many engineers, who furnished information, drawings and cuts, but it has been impossible to mention each individual. Literature bearing upon the subject was consulted, and general acknowledgment is made of the assistance thus obtained.

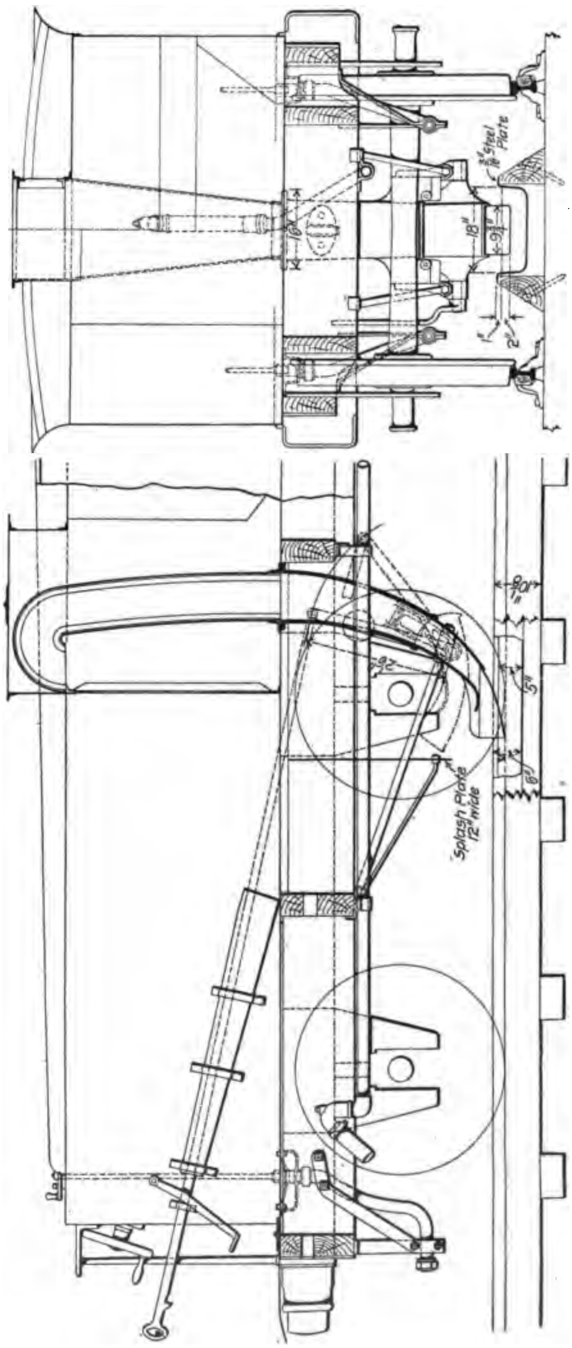


FIG. 49.

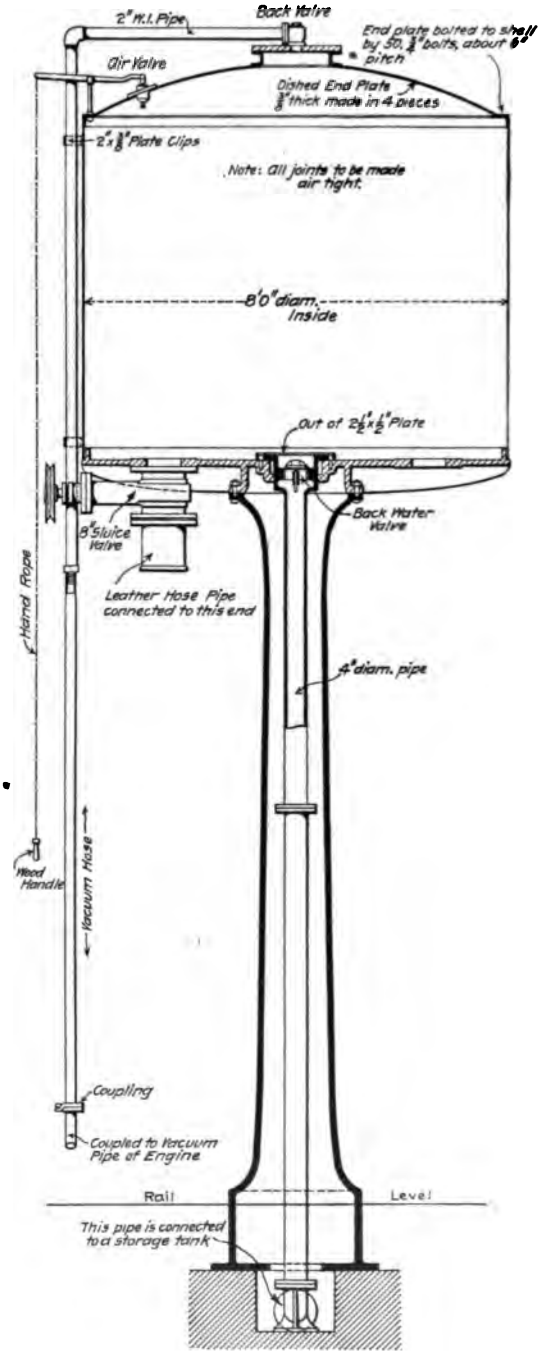

Back Valve
2" W.I. Pipe
End plate bolted to shell by 50, bolts, about 6" pitch
Air Valve
Dished End Plate thick made in 4 pieces
Plate Clips
Note: All joints to be made air tight.
8'0" diam. Inside
Out of Plate
Back Water Valve
8" Sluice Valve
Leather Hose Pipe connected to this end
4" diam. pipe
Hand Rope
Wood Handle
Vacuum Hose
Coupling
Coupled to Vacuum Pipe of Engine
Rail
Level
This pipe is connected to a storage tank

FIG. 50.

PROF. HIBBARD: I would ask the author of the paper whether the Kiesel patented scoop used on the Pennsylvania Railroad covers in the patent the principle of the eased curve as the shape of the scoop?

MR. WHYTE: I am not familiar with that, but I think it is simply the principle of counter-balancing the scoop. The scoop is so hung that the water striking back of the point of suspension counter-balances the effect of the water on the front end of the scoop. I think that is the principal feature of the patent.

PROF. HIBBARD: I asked the question because I hoped that feature was not patented. It seems to me that feature is quite an important one in the proper designing of a water scoop, namely, to have the scoop shaped in an "eased" or spiral curve; in other words, the same principle which is used in our railroad track curves, the rifling grooves of cannon, path of a comet, etc. If you want to alter the direction in which any body is moving in the natural and smoothest manner, you must alter it by making the alteration increasingly rapid. You are practically having a stream of water flowing against a fixed scoop, and if you want that stream of water to curve from a horizontal tangent up into the curved portion you should, properly speaking, have it an eased curve, starting the water to curve up very slowly at first and make it curve faster and faster until you get it shooting up into the direction of the now nearly vertical tangent.

In looking at these different designs of scoops, while, of course, it is difficult to tell by the eye whether the principle of the eased curve has been overlooked in all of them, except the Pennsylvania scoop in Fig. 43, yet I should judge, as near as I can tell, that the principle of the eased curve has been overlooked. If you look at Fig. 43 you will note that the distance from the point of the scoop to the lower fulcrum is a little longer than from the lower fulcrum to the first slide joint, the idea being that the water curves approximately the same number of degrees on either side of that fulcrum point, so that you get the balanced effect, and at the same time have the eased curve principle which will make it most easy for the water to rise from the track tank up into the vertical portion of the water scoop.

MR. F. F. GAINES: I would like to say a word, in the first place, in appreciation of Mr. Whyte's paper. I consider the paper

to be extremely valuable as a reference paper. A great deal of valuable data has been gathered and put in convenient form. I have not any criticisms to make. I would, however, refer to one or two little things in the way of omissions. Mr. Whyte speaks of locating the cranes at suitable points in the yard service. He should have gone further and taken up the question of the proper location of the water cranes or tanks on the road proper.

In my experience I have seen water cranes located in the most ill-advised places that could be found, in places where the train would be standing on a curve or at the foot of a grade, or where some other natural obstacle might be in the way, so that it would be difficult to pull out and start the train after taking water. I think that is a point which is overlooked to a great extent in locating water tanks. I think the form of spout is another thing to which attention should be called. In Fig. 2 the form of spout shown is a hinged spout which pulls down and necessitates its being held in that position while you are taking water. That is the ordinary form in which the spout is found on the average railroad. We have not all got track tanks on the road, and it is sometimes a great additional help to the fireman when he can have the three or four minutes that the water is running into the tank to look at the fire instead of holding down the waterspout. As an alternative to having the crane with the hinged joint to take care of variations in different heights of tanks, I would state it is our practice to use a standard height of crane, twelve feet over the rail, and then take care of the variation in tanks by having a boot leg, nothing more or less than a light, galvanized iron cone hanging on chains. When you sweep past the coal boards, this flexible boot leg is pushed aside, and when you come to the manhole it drops down, and yet it is long enough to deliver water to the lowest tank without spilling or trouble of that kind.

Mr. E. W. Pratt: It seems to me that a slight addition to the construction of some of these tanks, where the water is delivered directly to the tender of the locomotive from the tank, could be advantageously made by placing a drip pipe underneath the base of the spout when it is in the position of disuse, so that the water would be carried away from the track. Especially in winter, in the coldest portions of the country, this is of advantage, and we have found, as undoubtedly have others, that by discharging the

exhaust from the steam pump into the base of this drip pipe, the steam would rise and not only keep the connection between the drip pipe and the sewer open, but, except in the extremest weather and hardest winds, would keep a great deal of ice out of the spout. One of the objections, it seems to me, to the spout that rises and lowers, is the impossibility of proper counterbalancing the weight of the spout, especially when ice forms therein. The last speaker emphasized the advisability of allowing the fireman to do something other than attend to the spout, but when you get a spout that is operated by raising and lowering, and have a stand-pipe sixty or eighty feet high, I have seen cases where there was something back there for the engineer, as well as the fireman, to do. In this class of spouts, the accumulation of ice often makes the handling of the spout by the fireman dangerous, he being directly under the spout at the time, and pulling it down is very likely to sustain personal injury to the extent of a strained or broken back.

PROF. W. F. M. GOSS: Referring to the small tanks used in English practice, shown on pages 20 and 21, I would say that it is my understanding that these are employed when the water comes from some central source of supply, as for example, from a municipal piping system. In American practice, when water is taken from a city system, the stand-pipe is often coupled directly to the mains, and provision is made for meeting the stresses which are set up when the water is shut off by having ample relief valves. This small tank may be regarded as a substitute for such a system of relief valves, since the draft on the city mains is through a comparatively small pipe and is stopped gradually by a floating valve. Engine tanks are filled directly from the fixed tanks, the capacity of the latter being sufficient for one filling.

MR. H. H. VAUGHAN: I add my endorsement to that of Mr. Gaines respecting this paper. I think it is an admirable paper, one which is so well arranged as to be of great value as a reference paper, as Mr. Gaines says. I also call particular attention to the English construction shown, of sloping the ends of the track tanks with a gradual slope. That appears to me to be a very important thing. In Figs. 23 and 26, two track tanks are shown which are in use on American railroads, and in both of these tanks the end slope is very abrupt.

I do not think our experience is isolated in saying that this abrupt slope does not lift the water scoop if it is not properly raised before coming to the end of the tank. The dropping of the rails on the same slope as the bottom of the tank, while it will, of course, cause the tank to overflow if too much water is taken, at the same time will prevent, and would have prevented, these several delays to trains on account of the water scoops breaking. We have found that it is not only a question of the water scoop itself breaking, but in one or two cases the breaking of the water scoop has damaged the pipe inside the tender and let out the water, causing the engine to get dry and strain itself. In that connection, I would also call attention to the fact that it is necessary in these scoops to stay properly the upper end of the water scoop pipe. There is a very heavy strain on the scoop when taking water at high speed, and if not thoroughly stayed with the top of the tank, there is a liability for the connections at the bottom gradually to work loose and sometimes break.

In connection with the formulæ for theoretical height of water at given speeds, we made a test in reference to that and we found the speed to accord almost exactly with Professor Church's formula. At about half a mile an hour above the speed given in the formula for the height to the top of the scoop pipe of the tank, we began to get a little water, and at about two miles an hour above that, we got twenty inches in the tank, and the evidence seems to show that the formula can be depended on.

Another word in reference to the gradual curve. I think Prof. Hibbard is wrong in that. The proper curve for the bottom of the water scoop pipe is a circle which gives uniformly angular acceleration. On a railroad a curve of approach is given to change gradually the height of the outer rail elevation. The circle is the correct form for uniform acceleration.

I would add that the pneumatically operated scoop is satisfactory if the packing is kept up.

On motion, the discussion was closed.

THE SECRETARY: The following communications were subsequently received and added as a part of the discussion:

Mr. H. W. Cowan, Chief Engineer, Colorado & Southern Railway:

I will add to the discussion of the paper that for the past two months (previous to August 1, 1902) there has been a shortage of water supply in

the city of Denver from the regular water company's works, the city using before this shortage took place about 50,000,000 of gallons per day, which has been cut down to about 35,000,000 of gallons. All large industries have been cut in their supply, the water from the city coming from the Platte river direct and from storage reservoirs. During this period our supply from the points catching the underflow of the river has not been decreased or affected in any way, thus saving us the annoyance which other large concerns have had to put up with in this city.

Mr. F. W. Webb, Chief Mechanical Engineer, London & North Western Railway:

On reading through the paper I note that on page 29, referring to the water cranes used in England, reference is made to the one used on the Midland Railway as "a new 10-inch water column." I would point out that this is not correct, as exactly similar columns to those referred to have been used on the London & North Western Railway during the last thirty-eight years, and latterly, where parachute tanks have replaced the columns, we have used the latter for carrying the tanks. As, in consequence of having the track tanks so largely laid on our system, we find that 10-inch columns are not necessary, 8-inch being sufficiently large, and this is now our standard size.

With regard to the column tank shown in Fig. 9, they are largely used at places where engines are not taking water in quick succession, and where plenty of time is allowed for the tank to get refilled after having supplied one engine with water before another comes up. These tanks are supplied by a 4-inch pipe, whereas the ordinary water columns require an 8-inch pipe to supply them.

We do not find it necessary to heat the water in the track tanks during winter, but during the frosty weather men are told off to keep the troughs clear of ice, so that no difficulty is experienced in picking up water when required. When the frost is very severe we discontinue using the water troughs, and as in such weather trains have to stop more frequently for examination purposes, advantage is taken of such stops to get water at the columns on the station platforms.

The water scoops on our tenders are manipulated by the driver or fireman from the footplate, and the scoops in their normal position are raised quite clear of the water troughs, as shown by dotted lines in Fig. 49. When it is required to pick up water the scoop is lowered into the trough, and as soon as the tender tank is full the scoop is immediately raised out and clear of the water, so that no more water is taken from the trough than is actually required in the tender. Fig. 49 shows clearly the general arrangement of our water "pick-up" apparatus.

I would call attention to the remarks on page 39 concerning the water scoops as used on this railway, where it reads as though the scoops were always down, and when they came to a water trough scooped up the water whether it is required or not, whereas the scoop is lowered and raised as required from the engine footplate.

I also enclose you herewith a tracing (Fig. 50) showing a type of vacuum water tank which we have had in use for some time on some parts of our line. They are made from the same patterns as our ordinary standard water tanks, but in addition have an air-tight cover on the top. This type of tank is used in places where we have no water main or storage reservoir from which the tank could be filled by gravity, but where there is only a stream running by the side of the line. In this case we collect the water into a tank at or about the ground level, and connect it by a pipe to the water tank. As soon as an engine comes to the tank for water the driver couples up the vacuum hose pipe on the tank to the vacuum brake pipe on his engine, and creating a vacuum in the water tank, the water flows up the pipe into the tank. He then draws as much water as he requires for his tender, and when he has got sufficient, uncouples the vacuum hose pipe, leaving fresh water to flow into the tank in consequence of the vacuum that has been created, so that by the time another engine comes along there is sufficient water in the tank to supply the engine.

Mr. Robert J. Fisher, General Counsel, Eastern Railroad Association:

I have looked over the advance sheets on the subject of "Modern Water Supply Stations for Locomotives" with a great deal of pleasure, and have no doubt the information contained in them will be of service to me hereafter.

As I think it may be of interest to the members, I send herewith a copy of the drawings attached to the original Ramsbottom British patent, which was granted in 1860 (reproduced in part in Figs. 51 and 52). I send also a photolithographic copy of the patent to McDonald, No. 11,998 (reproduced in Fig. 53) which bears date November 28, 1854, and is, I think, the first instance of a water scoop for locomotive tenders. The device, as will be seen, is crude, and the tank, instead of being between the rails is on a single track railway, at one side of the track, and on a double track railway between the two tracks. McDonald was an American.

Mr. H. A. Hoy, Chief Mechanical Engineer, Lancashire & Yorkshire Railway, England:

The number of "parachute" water columns, shown in Fig. 12, on this line is 120. It is found to be well adapted for places where the pressure is not great and the supply is a small one. The tanks are generally placed at stations, the engine tank being filled while the passengers are changing.

Mr. H. A. Ivatt, Locomotive Engineer, Locomotive, Carriage and Wagon Department, Great Northern Railway, England:

The drawings shown of our float, scoop, etc., are all right. We are using the automatic float and it works very well. We have not had any severe weather during the year or two the track tanks have been in use on the Great Northern. I am doubtful whether trying to apply heat in our climate would be of any practical use, and I do not intend to do it myself. We sometimes get exceedingly severe weather for about a week, and when things are like that we stop the long-distance trains at an intermediate station for extra examination of wheels, brake, etc., therefore at

the time when the troughs are frozen we are rather glad of the opportunity to make the extra stop.

It will be noticed that our troughs are made of wood (commercial sized deals, creosoted), and fastened to the sleepers with cast-iron brackets. They seem to promise very well, and, I have no doubt, will last a long time, as, of course, they are always full of water.

The water cylinder arrangement for assisting the pulling out of the scoop works very well and gives us complete control.

Mr. W. J. Wilgus, Chief Engineer, N. Y. C. & H. R. R R.:

I have noted with much interest and pleasure the paper on "Modern Water Supply Stations for Locomotives," because the subject bears on one of the most important features of railroad service and is one that is too often treated as a necessary evil, without intelligent study for improvement and with haphazard methods of maintenance.

The constantly increasing weights and sizes of locomotives, with the demands of the Operating Department for a minimum of delays on the road and a maximum of mileage, require an ample and trustworthy supply of pure water, with quick delivery, at a reasonable cost.

For securing these results the locomotive water supply on the N. Y. C. and H. R. R. R. has been radically reconstructed during the past three years by the engineering department. A broad organization was mapped out for properly handling the subject, under the general direction of the mechanical engineer of that department.

Steam pumping plants have been rebuilt with up-to-date economical apparatus; gasoline and electric pumps have been installed where feasible to run several plants by one operator and at points where fuel could not be delivered direct from cars; gravity pipe lines and dams have been enlarged to increase the supply, and city and private water supply have been obtained where the railroad company's plants have furnished insufficient or impure water.

Samples of water from all plants have been analyzed and where the water has been found undesirable for locomotive boiler purposes, other sources of supply have been obtained.

Emergency pumping plants have been installed at gravity stations where the supply is liable to fail during droughts.

Twelve-inch supply pipes are used for connecting storage tanks with standard 10-inch water columns, so that not more than two and a half minutes are required for filling the largest locomotive tenders.

Water troughs of standard design are connected by large-sized pipes with the storage tanks to insure refilling in less than five minutes, thus permitting trains to follow each other in close succession.

The location of all water columns, storage tanks and water troughs is given careful consideration as bearing on the proper operation of trains.

The operator at each plant is required to render a monthly report of the total cost of pumping water, and a careful systematic record is kept by the mechanical engineer for comparing results as a guide for deter-

mining the best methods to be adopted in new plants, and for effecting economies in existing plants.

To illustrate the importance of the water supply on a large system the following table is given, from which it will be noted that 269 plants furnish daily 21,500,000 gallons at an average cost of 3.4 cents per 1,000 gallons.

It will be interesting also to note the comparative costs of pumping by various methods.

METHOD	No. of Plants.	Gals. per 24 hours.	Av. Gals. Per Sta. 24 hrs.	Av. Cost Per 1000 Gallons.	Total Gals. Per Year.	Total Cost Per Year.
A Steam Pump........	116	10,542,046	90,880	.02139	3,847,846,790	$ 82,311.15
B Gasoline Pump......	8	330,176	41,272	.02504	120,514,240	3,018.55
C Electric Pump	1	179,800	179,800	.02102	65,627,000	1,379.70
D City or Private W. Wks..............	81	7,341,581	90,637	.06725	2,679,677,065	180,222.40
E Gravity............	63	3,108,247	49,337	.00348	1,134,510,155	3,956.60
Totals.............	269	21,501,850	....	.02451	7,848,175,250	$270,888.40

A, B, C and E do not include interest and depreciation on plant.

The attached form will give a very good idea of the complete way in which some of the records are kept.

Mr. S. W. Johnson, Chief Locomotive Superintendent, Midland R'y, England:

The size of the pipe leading to the water column, Fig. 19, is 10 inches diameter inside, and with a supply tank 30 feet high is capable of delivering 4,500 gallons of water into a tender in about three minutes. The column under ordinary conditions is full of water up to the bottom of the neck to which the leather bag is attached, but in very severe frosty weather the column can be emptied by means of a ¾-inch bib tap screwed into the boss at the bottom of the column and connected to a drain. This seldom has to be done in this country. These columns give every satisfaction and their upkeep is very small.

Mr. G. J. Churchward, Great Western Railway, England:

The general impression given in the paper concerning the water appliances at Reading is correct to a certain extent, but it should be added that cranes have been erected behind all signals where trains are likely to be brought to a stand, thereby enabling engines to take water without causing unnecessary delay. The two cranes on the platforms are to accommodate long and short trains.

With regard to Fig. 33, the reason we have turned the flanges of the water troughs inside, and have the projecting flanges on the sides of the scoop is to prevent waste, and there is no doubt the inside lip answers this purpose.

The automatic float control governs the whole of the track tanks laid down at each spot, whether for four lines or two. We do not use a separate float control for each tank.

I may say that the automatic control as used on the Great Northern Railway of England, shown in Fig. 31, is identical with that used on this railway as shown in Fig. 32, as it was copied from us.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

LEASED AND OPERATED LINES.

MAINTENANCE OF WAY DEPARTMENT.

LOCOMOTIVE WATER STATIONS.

..........................Division. Report for Month ending..................................190....

No.	Location	Sub-Div. No.	Water Average Gals. 24 Hrs.	Fuel		Supplies—Cost Per Mo.				Rent or Taxes	Attendance		Total Cost per Mo.	Cost per 1000 Gals.	Cost of Repairs	REMARKS
				Pounds or Gals	Cost Per Mo.	Mach. Oil	Cyl. Oil	Lig't Oil	Waste		Hrs.	Cost				

We have not found it necessary to heat during the winter the water in the track tanks. At some of the troughs the trains pass over so frequently that sufficient time does not elapse between them to allow the water to freeze; in addition, we have a man employed to keep the troughs clear of ice and, so far, we have found this satisfactory.

THE PRESIDENT: We will now receive the report of the Committee on Correspondence and Resolutions.

Mr. Whyte presented the report of the Committee on Correspondence and Resolutions as follows:

Resolved, That the hearty thanks of this Association be extended to Mr. Waitt for his admirable address, to the Committee of Arrangements for the preparations made by them for the convention, to President Knapp and the Village of Saratoga Springs for the hearty welcome, to the American Locomotive Company, Schenectady Works, for the entertainment tendered by them, to the proprietors of the Grand Union and United States hotels for their hospitality, to the railroads which extended courtesies, to the Supply Men's Association for their attention, to the press in general and to *The Daily Railway Age* in particular, for their support.

J. H. McCONNELL,
L. R. POMEROY,
F. M. WHYTE.

MR. SINCLAIR: I move that the report be adopted.

The motion was carried.

THE PRESIDENT: We will now hear the report of the Committee on Subjects. As there is no member of the committee present, I will ask the Secretary to present the report.

The Secretary presented the following report:

REPORT OF COMMITTEE ON SUBJECTS.

To the President and Members of the
American Railway Master Mechanics' Association:

Your Committee on Subjects would report as follows:

FOR SUBJECTS FOR COMMITTEE INVESTIGATION DURING THE YEAR 1902-3.

1. A committee to be appointed and continued until after the 1904 meeting of the International Railway Congress, said committee to work in conjunction with the American Society of Mechanical Engineers, the American Institute of Mining Engineers and the International Association for Testing Material, in preparing standard specifications for locomotive forgings, and to report progress and results of their investigations to this Association in 1903, and each successive year until their work is completed and the committee discharged.

2. What is the most satisfactory practice for setting flues in the fire-box end of a locomotive boiler, and what is the best style and form of tool for setting and repairing same?

3. What is the best arrangement of drawbar and buffer attachment for use between engine and tender; what should be the form and relative strength of drawbar to the tractive power of an engine, and what offset in the bar is permissible?

4. What is the best kind of light in the locomotive headlight for economy per unit of light, and what standard constitutes sufficient light for the purpose?

5. Strength versus Size of Locomotive Boilers: What will produce the greatest economy for a given weight of boiler — high pressure and boiler built strong enough to sustain same, or lower pressure with increased heating surface.

6. If the committee that now has question No. 4 for this year does not cover this point, I would suggest that the committee be continued, or a new one appointed, to determine what shall be the relative grate and heating surface for different kinds of fuel as applied to compound two or four-cylinder locomotives.

7. What is the best practice for painting locomotives and tenders, cost, durability and appearance all being considered, especially bringing out any economical appliances which have been utilized to assist in this work.

FOR TOPICAL DISCUSSION DURING THIS CONVENTION.

1. Is the Master Mechanics' Association's standard front-end arrangement best adapted to the modern locomotive, having wide fire-box, increased length of flues and larger grate area?

To be opened by Mr. Jas. McNaughton.

2. Will the use of a tire-dressing brake shoe lengthen the time between shoppings of a locomotive; will it increase or decrease the number of miles per 1-16 inch wear of tire, and should the practice in any way be modified where the service covers long, heavy grades?

To be opened by Mr. A. L. Humphrey.

3. Does the extension of the smokestack into the smokebox materially assist in the steaming qualities of an engine, and minimize the danger of such an engine throwing sparks?

To be opened by Prof. W. F. M. Goss.

4. Piston versus solid valves in high-pressure engines.

To be opened by Mr. F. H. Clark.

5. The best proportion of heating surface and arrangement of fire-box with draft appliances for oil fuel in locomotives.

To be opened by Mr. H. J. Small.

6. Has the use of flexible stay-bolts in side-sheets of locomotive fire-

boxes overcome the difficulty of broken bolts, and have the benefits derived from same been enough to overbalance the extra cost of the flexible stay-bolts?

To be opened by T. A. Lawes.

A. E. MANCHESTER, Chairman,
HOWARD STILLMAN,
ALFRED LOVELL,
Committee.

MILWAUKEE, WIS., May 17, 1902.

THE PRESIDENT: The subjects have all been before you, and the topical discussions we have on our program. I do not think that any action is necessary, except to assume that the report is in your hands and you have all considered it. What is your pleasure regarding the report?

MR. SINCLAIR: I move that it be received and the subjects referred to the Executive Committee.

The motion was carried.

THE PRESIDENT: We will now hear the report of the Auditing Committee.

MR. WHYTE: The Auditing Committee finds the accounts of the Secretary and of the Treasurer correct. There are no unpaid bills, and the funds in the hands of the Treasurer amount to $2,700.89.

On motion the report was received.

THE PRESIDENT: With that necessarily goes the approval of the reports of the Secretary and Treasurer.

We will now take up the topical discussions. The first is, "Piston versus Slide Valves in High Pressure Engines." The discussion will be opened by Mr. F. H. Clark.

Mr. F. H. Clark read the following discussion:

Our experience with piston valves in locomotive service dates back to 1895 when we ordered a Columbia type engine with 19 in. x 26 in. cylinders and 84 in. wheels for fast passenger service. This engine had piston valves 9⅛ in. or 10 in. in diameter, a 6 in. maximum valve travel and 1 in. lap. The packing rings were rectangular in section and about 9-16 in. wide.

In the following year we applied piston valves to a slide valve mogul engine by substituting a valve cage and valve for the steam chest and slide valve previously used. We did a good deal of experimenting with both engines and finally reached the conclusion that we would make no

mistake in building engines with piston valves. We now have about 150 of these engines on the Burlington system, exclusive of four cylinder compounds and nearly as many more ordered for delivery in the next eight or nine months.

The principal advantages of piston valves result from the fact that it is so nearly balanced that the friction is reduced and this of course means less friction, springing and wear in the eccentrics, links and other parts of the valve gear and power saved for useful work. Tests made in 1896 on the 19 in. x 24 in. mogul engine fitted with piston valves seemed to indicate that the friction was less than one half as much as with slide valves.

The first fifty or more piston valve engines that we built had 19 in. x 26 in. cylinders and 10 in. valves, but these valves were considered to be pretty close to the limit in size except for switch engines and on more recent road engines with cylinders 20 in. x 24 in. larger, 12 in. valves have been used. The packing rings are all of the L section with 5/8 in. outside bearing, 1/4 in. projection and varying depth. These rings give better satisfaction than the plain rectangular ring, though perhaps they are somewhat less durable. Although on the whole I think the piston valve may be said to be fairly established, there is room for improvement both in design and practice. There seems in some quarters to be a tendency to expect too much of it and to fail to take the same care in fitting up and in renewals that all expect to give to slide valves. I believe we can well afford, if necessary, to give it even more attention than our slide valves demand.

THE PRESIDENT: The subject is now opened for general discussion.

CHAS. M. MUCHNIC M. E., Wis. Central R'y, (*communicated*):

I note from the advance sheets and programme of the convention that there will be a discussion on the piston versus the slide valve. Not being able to be present at Saratoga this year I am pleased to send you a few remarks regarding the cylinder head relief valves on piston valve engines.

It is well known that with the ordinary slide valve, when there is an accumulation of water in the cylinder, the piston in its movement forces the water through the ports to the valve seat, which in turn lifts the valve from its seat and lets the water pass into the steam chest. This will also be true for any excess pressure on the piston and head that may take place at the end of a stroke. With the piston valve as is used on our engines—a drawing of which I herewith attach—the valve sets solid in the bushings and will not admit of any water or steam to pass over from steam port into steam chest when that port is closed by the valve.

To provide against this the builders of the first lot of our piston valve engines (in 1897) have provided each cylinder head with a 2 inch "knuckle" pop valve set a few pounds above the boiler pressure. These relief valves have given in service considerable trouble from leakage, or otherwise, with the result that they were taken out, the holes plugged and the engine run for months without relief valves.

The blowing out of cylinder heads with this class of engines became rather frequent, and it being mostly the forward cylinder head, it was thought that it lay in the weakness of the head. These were consequently reinforced, but the trouble still continues. Some of the blown out cylinder heads have relief valves in them.

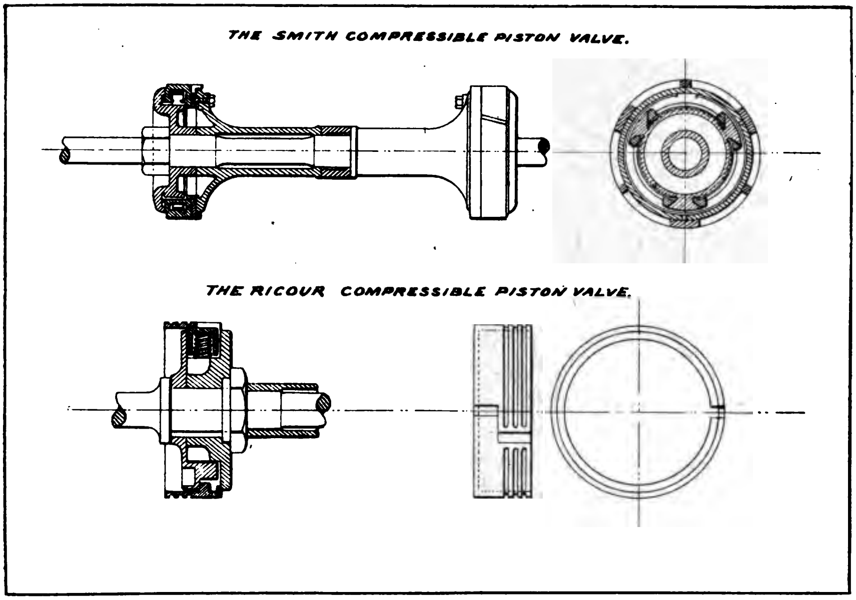
It occurs to me, therefore, that the blowing out of the cylinder heads is largely due, if not wholly, to the inability of the piston valve to lift itself from its seat as the slide valve does, and to a faulty design of the cylinder relief valves in perhaps not having sufficient aperture to relieve instantaneously the excessive pressure that is brought to bear upon the cylinder head and piston equally. What this pressure will be will depend on many variables and would be hard to calculate. However, we can know approximately what that is by finding out what force it will take to rupture the head at its weakest point.

The normal pressure on the cylinder head of a 20 in. diameter cylinder at 200 lbs. pressure would be 62,832 lbs. To rupture the cylinder head in question at the weakest point would take an estimated force of about 66,000 lbs. Suppose that the cylinder heads were made of proportions large enough to withstand with safety such an enormous stress, we would also have to increase the proportions of our rods, pins and other parts of the engine frames to equally withstand this maximum stress, the pressure being transmitted equally in either direction. This being said, it would be interesting to know what has been the experience of other members on this particular feature in connection with the piston valve, and their views on the same.

It may also be well to mention here of piston valves that have come under my observation and so designed as to answer the purpose of the relief valve or the lifting of the slide valve.

These valves with which the members may be acquainted are the Ricour piston valve, as used in France for many years with fair success, and the Smith valve, as used on several roads in England with equally fair success. I inclose sketches of both of these valves that clearly show their construction. In the Smith valve it will be noted the packing consists of one complete ring of the ordinary type, and a second ring made in three distinct segments. The points of these segments come on the bars across the port openings. Steam is admitted behind the segments so that each constitutes a sort of slide valve by itself. The valve thus acts as a relief valve in case of the water reaching the cylinder. The segments then yield inwardly and the water thus got rid of return to their seats.

The "Ricour" is similar in action but simpler in construction, it having but one packing ring as shown on sketch. In bringing these valves to the attention of the members it is not with the intention of recommending them, but merely to point out a condition the piston valve should fulfil, or if simplicity of construction of valve is desired to provide an efficient device to answer the objection above mentioned, to the rigid piston valve.



MR. GEORGE W. WEST: I have heard the same objection raised to piston valves, and I would ask Mr. Clark if any of the divisions over which these engines are operated have any considerable opportunity to coast or run without steam. I understand the piston valve is hard on the reverse lever parts when running without steam on a down grade of eight or ten miles.

MR. CLARK: I will say in reply to Mr. West that we perhaps do not do so much coasting as is done in the East, but we have occasional stretches of eight or ten miles over which the engines run down hill without steam. I do not know that we have any difficulty in lubricating the valves, but we find on some engines at least, if we let the reverse lever down in the corner, the valve motion will make trouble; but, on the other hand, we do not want it too near the center. I think in the position that would give us 60 to 75 per cent. cut-off, we have no immediate trouble with the piston valves.

MR. WEST: This matter was discussed at the Central Railway Club three or four months ago, and I think the traveling

engineer of the Lake Shore road was present, and if I remember correctly it was he who made the statement that the piston valve would practically lubricate itself under steam, and that he had several times taken the reverse lever at 200 pounds pressure and was able to reverse the engine at full speed, but that when running without steam it was dangerous to touch the lever in almost any position, and that they found it required a great deal of oil to lubricate the pistons and valves when running without steam. Of course, that is the experience of some one else, not my own, and I would ask if it can be corroborated by any one present.

MR. C. H. QUEREAU: I have had an experience with piston valve locomotives for something over two years, and in one case they drifted 62 miles, using steam only in going out of the stations. The grade is not very steep, except for a third of that distance, but it is sufficiently so that trains will make time card speed, about thirty-four or thirty-five miles an hour, without the use of steam. If the reverse lever is placed in such a position as to give approximately 50 per cent. cut-off, there is no difficulty in the jerking of the reverse lever, and no wear on the valve gear more than ordinarily. But that possibly would apply only to the design of piston valve with which I am familiar. I have heard the same statement made on a number of other roads that there is a position of the reverse lever where there is no unusual jerking. I am very favorably impressed with the piston valve, not only from theoretical considerations, but in practical service, and it is a fact that at the highest speeds, with the wide-open throttle, they can be handled easily with one hand if properly designed. There is, however, a feature concerning which I am not entirely satisfied, and one on which I think observations might well be made: With the ordinary slide valve, as it and its seat wears, the wear is taken up by the weight of the valve. No such condition exists with the piston valve beyond what may be taken up on account of the spring of the packing strips. I am inclined to believe, although I am not at all positive, that with the piston valve for these reasons there may gradually grow a loss of steam due to the packing rings not properly fitting the bushing. It seems to me that it is advisable—and yet I have no facts to substantiate my opinion—that this point is well worth investigation. I can conceive that such a leak might grow without being perceptible. It would come so gradually that

the engineer's attention would not be attracted to it as it would in the case of a broken D valve, with a cut seat or valve, and in the course of time the loss might be considerable.

MR. ANGUS SINCLAIR: I have had a considerable experience with piston valves at sea, which I was going to say convinced me that this is true, but perhaps I became prejudiced against the valves from the fact that never by any chance were they steam tight. A piston valve always leaked. The marine engineers recognize that by putting a slide valve on the low-pressure cylinder. I have not seen any particular reason in the case of piston valves on locomotives to convince me that they are any different, or that the objections which were raised to them in marine service do not exist in the case of locomotives. However, they seem to be highly in favor these days, and it is not for me, I suppose, to argue against them. But I think it would be a good plan for those who seem to be so much in favor of piston valves to find out how much the leakage amounts to. I did not rise, however, to make this statement.

For years past, since we are having powerful engines, engines developed in accordance with the immense power that has to be transported to-day, a great deal of attention has been bestowed upon the strengthening of the cylinder connections to the frames. The designers have done everything in their power to make the connection between the frames and cylinders as rigid as they possibly could, and one development of that has been to bring the frames above and below the cylinder casting. That was recognized to be a great improvement. It was well known that it kept the cylinders from becoming loose, a great trouble with cylinders which had previously existed. Now, when the piston valve came in, they throw away that advantage of having the frame above the cylinder casting and have gone back to the old way of a single bar merely for the purpose of getting a piston valve at the place where the frame had previously been. I do not think that is good practice. I know that engineers of my acquaintance are having trouble with the frames loosening, the same as before the stronger construction was introduced, and why you should agree to give up that admittedly strong form of construction for an admittedly weak one, merely to have a piston valve, which is of doubtful utility, is something I do not understand.

Mr. C. A. Seley: I beg to advise Mr. Sinclair that the Norfolk & Western road has piston valve engines with the piston valve located almost directly between the bars of the double frame in one class, also other classes with the piston valves on top of the cylinders, with their centers exactly similarly located to the center of the yoke of the slide valves that are employed on a portion of that class of engines. They have also some passenger engines with piston valve and single bar frame. The idea of the Norfolk & Western road was to keep the double-bar frame for heavy engines where there is probability of double-header service, and to make a strong front-end connection.

I would ask some of the former speakers who have had experience with the piston valve, for some information relative to one point, and that is, as to whether they have found it advisable to have a hollow valve. As most of the piston valves are inside admission, the exhaust is discharged into the ends of the chamber and there is a considerable recoil, particularly when the engines are running slow. The practice of the Norfolk & Western has been mainly in the direction of solid valves, although some experiments have been made with the hollow valve with a view to the possible softening of this recoil. My reports in this connection are incomplete, and as doubtless other roads have, perhaps, experimented in the same direction, I would like, if possible, to have information on the subject.

Mr. G. A. Hancock: As I have had some experience with piston valves during the past year, I will give you an idea as to the wear of same. An 18x24 engine, carrying 180 pounds of steam, making ten or twelve thousand miles per month, was fitted with a piston valve without packing rings, in place of the ordinary slide valve. At the end of six months the valve was examined and the wear was hardly perceptible. Similar valves were furnished for a tandem compound, and at the end of three months a test was made against a simple engine of same capacity, and it showed a saving of 18 per cent in fuel, in favor of the compound, which demonstrates that there was very little waste on account of valves wearing and blowing. The compound engines are provided with relief valves and there was no trouble with engines while drifting. No relief valves were provided on the simple engine. We decided that there was very little advantage in the

use of the piston valve on simple engines other than that it could be handled easily, but on the tandem compound engine the ease of handling constituted an important advantage.

MR. F. F. GAINES: I have lately had some experience with a new type of slide-valve which I think is interesting and valuable, and I may speak a little about it. This type of slide-valve is absolutely and perfectly balanced. The engine carried 200 pounds of steam, and at any time it is in it with the piston valve as far as balancing is concerned. It has the further advantage that the packing for balancing the apparatus is absolutely stationary. There is no movement to it whatever; and from past performances we have every reason to expect that the future will be the same. The wear will be a minimum, and the only wearing surfaces are the valve seat and the upper plate, which is identical with the valve seat. With this type of valve, owing to its perfect balancing you can do everything that you can with a piston valve, external or internal admission, and you further have a double port arrangement, not like the Allen but simpler and more effective; and, while there has been no absolute test made on it, yet the opinion of the road foreman is favorable to it, and the engineers and everybody concerned have been greatly pleased with this valve. I consider it a step forward in valve motion. I think it overcomes many of the objections of the piston valve, and at the same time there is in this valve every inducement a piston valve can possibly offer.

MR. W. O. THOMPSON: I confirm Mr. Quereau's remarks about the leakage of steam in the piston valve. My observation is that we have a large waste of steam in our engines at the present time equipped with the piston valve, through the steam leaking by the packing—the snap-ring, so called. I believe the remedy for that would be to use sectional packing instead of the solid packing, more commonly known as the Dunbar packing.

MR. SYMINGTON: I know of one large road where they had trouble with the packing rings leaking in piston valves, and they started to remedy it by turning up the packing rings eccentrically, in the same way that packing rings in the air brake triple valve are turned up, and the ring, in springing open, would spring more nearly to the circle, and they claim they have very much reduced leaking of steam after the introduction of that practice. I do not know whether that is true or not, but the rings have been in service

some eight or ten months, and I should think theoretically that the practice is a good one.

MR. GEORGE L. FOWLER: This leakage of steam past the rings of a piston valve has been taken by the horns by the Smith Superheating Company, in Europe. They have done away with the packing rings entirely, and use simply a plain, plugged valve without any rings whatever. Of course, that is liable to grab and stick and make trouble; so that, with the European disregard of complications, they have jacketed the outside of their bushing with live steam to keep it expanded, and jacketed the inside of the valve with exhaust steam to keep it contracted, and leakage past the valve is no more than the ordinary piston valve with the rings.

MR. F. M. WHYTE: Reference has been made to the broken cylinder heads on locomotives equipped with piston valves. I think this experience has been had by a large number of roads using the piston valve, and to a large extent it has been overcome by shortening the water-gauge glass. The piston valve will not free the cylinder of water quite as freely as will the D valve, and the engineers are apt to keep the water near the top of the water-gauge glass and therefore a considerable amount is carried over. This is decidedly objectionable when using the piston valve, and by shortening the glass the water is carried at a lower level in the boiler, and as a result water is carried over into the cylinder.

MR. J. A. CARNEY: I have had some experience with piston valves, and find that the advantages which the valve presents are longer ports than it is possible to get with a slide valve, a good steam admission and very nearly an absolutely balanced valve.

It was found in the first piston valves used, that in setting them to the same lead and lap that was customary with the slide valve, that too early an exhaust resulted, especially when the valve was given exhaust clearance. The result was that while there was a good steam admission, the exhaust was so early that the steam did not make its full expansion. One of the disadvantages of the piston valve is the rapid wear of the rings. It has been found from experience that the steam ring does not give much trouble from leaking, except at the point where the two ends of the ring come together; but that the exhaust ring after a certain amount of wear will close down over from the pressure of the exhaust and the steam will blow around the rings, so that a piston valve which

has been in service for some length of time will show a very free steam admission and cut-off, but the exhaust will be in very poor shape. The result is a weakened engine and one which uses an excessive amount of coal and water.

Mr. C. H. Quereau: So far as my personal experience goes, and that of at least one other road in this matter, I think it is worth calling the attention of the members to the fact that for an internal admission valve the valve gear must be designed especially for that valve. I know in the first locomotive with which I had any experience with the piston valve the lead and cut-off could not be equalized. I know that another road put valves of the internal admission type on a locomotive without making any other change in the valve gear, and they had identically the same experience. On going into the matter we found it was necessary because of the reversed positions of the eccentrics for the internal admission valve to redesign the entire valve gear to get proper results. It is possible that the defect to which Mr. Carney alluded, of too early exhaust, may have grown out of the lack of this knowledge.

Prof. Hibbard: I would corroborate Mr. Quereau in that regard. I had occasion at one time to design a two-cylinder cross-compound locomotive, and in order to get the receiver pressure on the valve rod packing, both high pressure and low pressure, I made the best attempt I possibly could to have the internal admission valve for the high pressure, and the external admission valve for the low pressure, but I found I could not do that and have the two valve gears at all alike, and I had to drop the idea completely.

Mr. C. A. Seley: I might say in regard to the point brought up by Mr. Quereau, that it is an annoying thing and one that cannot be perfectly overcome. The valve motion for a simple engine that I have in mind, employing slide valves, outside admission, equalized perfectly over the whole quadrant with a link saddle pin offset of 13-16 of an inch. When a piston valve, with inside admission, was applied to that type of engine, experiments showed that for equalization at the principal running point it would require an offset of nearly an inch and a half. This amount of offset is very undesirable and contributes to making the reverse lever handle hard. It is impossible to make such engines equalize in the cut-off except at one point. That is, the range over the quadrant

will show heavy cut-off at one end and light at the other, and gradually equalize as the lever is drawn up and then it crosses over, making the cut-off heavy at the other end and light at the opposite end. It also has its effect on the indicator card, more particularly on the exhaust and compression lines, and I have failed to see satisfactory indicator cards on inside admission piston valves using indirect motion. If, however, the motion is reversed and made direct, as has been done in a number of recent designs, we can then get back to proper equalization.

In connection with the safety devices which of necessity have to be used with piston valves, I do not think any relief valve is as satisfactory as one employing a spring of considerable length, having an open cage so that the spring can be exposed and free itself of any accumulation of cinders, or sand, or dirt, and be easily cleaned out with the hose or air.

I notice also one other feature in connection with piston valves, and that is in reference to the attempts made to get a by-pass. I do not believe there is anything in it on simple engines. In going to piston valves on the 21x30 consolidation engines on the Norfolk & Western, we thought, of course, we had to put on the by-pass valves, and we designed what we thought was a good one, looking very fine on paper, but the expectations were not borne out by the engine. They were not put on in the exposed position on the outside of the cylinders, but on the back of the piston valve chambers out of reach of harm. Much to my surprise on riding on the engines I could hear these valves click, whether the steam was off or on, apparently having motion in either case. Lack of time prevented a thorough investigation as to why the valve acted that way, but to make matters short we took the valves out and put on a plate, and indicator cards, taken when the engines were taking steam, and drifting without steam, showed that we had no action from these valves in the expected direction. We therefore stopped up the cavities on these cylinders in construction thereafter, and none of the piston valve engines of the Norfolk & Western, of the class W type, are now made with the by-pass valve, and they will go down hill as fast as the trainmen care to go. There does not seem to be any trouble with the piston valves of these engines in regard to remaining tight; and it is the belief of the department that they are as fairly economical as slide valves.

MR. DAVID VAN ALSTINE: Can we get any infomation as to the economy in the use of piston valves? From what figures I have gathered I do no find there is any saving in piston valves compared with slide valves. I have been told that on the Rock Island they find a considerable saving; and that, on the other hand, on the B. C. R. & N. they find a loss, unless hauling very heavy trains. I believe on the Lake Shore they find the piston valve desirable on the more powerful engines at high speed, but they do not find any difference in the coal consumption.

MR. E. W. PRATT: Inasmuch as the Lehigh Valley seems to be the only road using a slide valve where the area of the ports are entirely compensated for or the valve completely balanced, and as the advantage of a piston valve is largely due to that point, and also the larger port opening, it seems to me that it would be very interesting if the Lehigh Valley would give what data they have to be printed with this discussion, and also any indicator cards showing particularly the relief of steam from the cylinder under high speed, which is one of the particular advantages we find, of course, with a piston valve.

MR. GAINES: I would be glad to furnish the information suggested if it were possible at this time. The valve has been in use about nine months, but so far there has been no opportunity, owing to the pressure of other work, to absolutely indicate the apparatus and make a test of it. The practical operation, however, has been so satisfactory that not only our road but other roads intend to apply this type of valve in the near future. If I could I would be glad to comply with the suggestion, but am unable to do it, to go in with the Proceedings of the convention.

F. H. CLARK: I am unable to say whether piston valve engines require any more oil when drifting than the slide valve engines, but, I think, on the whole they require about the same amount of oil as the slide valve engines.

I think that we are correct in assuming that with the ordinary construction of piston valve packing rings there is a gradual increase in the loss of steam on account of the wear of the rings and bushings, but I believe that if properly designed and fitted up the loss would be insignificant at the outset and would increase so slowly as to call for comparatively little attention. One of our Master Mechanics who has had a good deal of experience with

piston valve engines states that in his opinion the rings need not be removed oftener than from six to nine months. The leakage generally takes place at the joints between the ends of the packing rings, and also at times around the circumference of the rings when considerably worn.

As to the point made by one of the speakers in reference to the single bar front frame construction I would say that we have but one of these single bar frame engines with piston valves, and that some of the valves are located above the cylinder and others in the saddle between the upper and lower bars of the frame. We have found it easier to get a stronger construction with a two-bar frame, although I believe that a single bar frame if well designed would be perfectly satisfactory.

We have used both the hollow and what has been referred to as the solid valve (without any opening between opposite ends) and our experience has been that the hollow valve is very much preferable.

The necessity for relief valves is perhaps an open question, although I am of the opinion that if of sufficient capacity they are well worth having.

One of the members brought up the point that with an internal admission valve the valve gear must be designed especially for that valve. I think he is correct if he has in mind the use of the reversing rocker arm, but understand if a direct motion is used the same proportions may be used as for the ordinary slide valve with outside admission and reversing rocker.

I have made no attempt to determine the relative economy of piston and slide valve engines, but I cannot see why there should be any marked economy if the distribution is all right in the case of two engines under comparison. I think, as already stated, that the principal economy results from the reduction of the friction of valves and valve gear.

MR. DAVID BROWN: The matter is an important one, and there are several opinions on the matter. I have mine, but it is not necessary for all of us to give our opinions. At the same time, I think the matter is of sufficient importance that it would be well to continue the subject; and I move that the matter be taken up as a topical discussion next year, and probably at that time we will have further data relating to the valve Mr. Gaines speaks of.

The motion was carried.

THE PRESIDENT: That disposes of this subject for the present. We will now take up the next topical discussion: "Does the Extension of the Smokestack into the Smokebox Materially Assist in the Steaming Qualities of an Engine, or minimize the Danger of Such an Engine Throwing Sparks?" This topic will be opened by Prof. W. F. M. Goss.

PROF. GOSS: Mr. President and Gentlemen: Such information as I have upon this subject was obtained in the course of a research which has been in progress in the laboratory of Purdue University under the direction and patronage of the *American Engineer.* I am sure that I violate no confidence, however, in presenting to you a very brief summary of some of the results of this research in advance of their being reported to the *American Engineer.*

Referring first to outside stacks, I would say that it seems settled that, other things being equal, the higher the stack the more efficient the front-end arrangement. A 60-inch stack is better than a 24-inch stack. As the boiler is set higher, and as it is increased in diameter, the length of outside stack must be diminished and with each reduction in length of stack we lose slightly in efficiency.

Now, the advantage of the inside stack, as used on some roads, is to be found in the fact that it serves to maintain the length of stack and at the same time the amount projecting above the top of the smoke box is not too great for clearance. Therein, as I understand it, lies the advantage of the inside stack. It is evident, of course, that as the stack is extended downward into the smoke box the nozzle also should be lowered in order that a proper distance between the nozzle and bottom of stack may be maintained. It is interesting to note, however, that with the inside stack the desirable distance between the nozzle and the bottom of the stack may be much less than is usually assumed to be necessary between the nozzle and the base of the outside stack. Experiments which we have made show that the distance from the lower edge of the bell of the inside stack to the top of the nozzle may be as small as ten inches, and yet maximum results be obtained. This, you see, admits of having a very considerable extension of stack down into the smoke box, without the necessity of very much lowering the nozzle. I believe it is possible, by means of such an arrangement, to secure for large engines the full advantage of the long

stack previously used on small engines for which outside stacks only were used.

I should add that the inside stack, which was the subject of the experiment, had a bell at the bottom, increasing in diameter from fourteen inches, the diameter of the stack, to twenty-four inches, the diameter of the bell. In addition to the advantage of giving the effect of the long stack, it seems to me that the adoption of the inside stack will sooner or later lead to a simplification of the inside arrangement of the front end. I believe that by lowering the center of activity within the smoke box, the advantage of the diaphragm, which was the subject of discussion the other day, may be diminished and we shall find a way to greatly enlarge the opening under the diaphragm or perhaps get along without it altogether, so that there may be a two-fold advantage in using the inside stack; first, by its use we may maintain a proper length of stack, and secondly we may change the center of activity within the smoke box to such an extent that it may be possible to eliminate the diaphragm.

The subject which was assigned to me also includes the question of sparking, and upon that phase of the question I cannot speak, since I have done no work upon it in connection with inside stacks.

MR. JOHN PLAYER: I notice that Prof. Goss has recommended the extension of the stack downward inside the smoke box, or as he termed it, an inside stack, to provide a sufficient amount of draft. We went into that thing some years ago, when we first built the large engines with short stacks, and although theoretically you obtain really better draft than you do with the outside stack, yet we found that in actual operation with an engine provided with the inside stack, as the engineers and firemen termed it, "kicked back" when you shut off, so much so as nearly to drive them out of the cab. In other words, it was a very long time from the period of shutting off steam until a sufficient amount of draft was obtained through the inside stack to clear the smoke box and consequently the fire box. When we went into the use of Wooten fire boxes burning bituminous coal, the objection became far more apparent, and we had to abandon the inside stack as a continuous stack, and cut it off at the base, using a lift pipe, practically the same size as the inside stack would be, leaving an open-

ing about two inches in depth of the circumference, around the base of the stack, so as to permit the front end to clear itself. I would ask Prof. Goss if he has made any experiments in that direction, because that was one of the most serious objections raised against the inside stack by the men operating on the road.

PROF. GOSS: I must answer that I have made no experiments along that line. The work which I have undertaken to do on the inside stack has been limited in its scope. It appears to me that the petticoat pipe, as applied to many engines, may in part take the place of the inside stack, and by the use of such a device it may be possible to get the same degree of efficiency in connection with outside stacks that we have obtained with the inside stack.

MR. F. T. GAINES: I confirm to a certain extent what Prof. Goss has said. Our practice has been for a number of years to have practically an inside stack — although we do not call it that— we call it a "petticoat," but it is practically an inside stack. The sheet-iron fits up snugly, and goes down something like ten to twelve inches, with a flare for attaching the netting. We also find, in confirmation of another expectation of Prof. Goss, that the diaphragm plate, is altogether unnecessary, or becomes very small, not over six or eight inches down toward the bottom of the flue.

MR. SYMINGTON: I have done a great deal of experimenting with stacks and front ends, and I would like to say that the difficulty mentioned by Mr. Player is one which everyone will find when you extend the stack down into the smoke box—the engines will kick back. I overcame that trouble entirely on some engines by cutting off the upper part of the smoke box by putting in a blank plate from the flue sheet forward just above the level of the bottom of the extension. This is a very small thing to do and the reduction of volume in the smoke box does not affect the steaming of the engine at all, and I think if it is tried on either the narrow or wide fire box engines Mr. Player will find that trouble will cease.

THE PRESIDENT: Is there any further discussion?

MR. PLAYER: I would ask if it was carried back to the flue sheet, or to the steam pipes?

MR. SYMINGTON: It was carried back to the flue sheet, resting on the top of the diaphragm.

Mr. West: I move that the discussion be closed.

The motion was carried.

The President: The next topic for discussion is: "Has the use of flexible staybolts in side sheets of locomotive fire boxes overcome the difficulty of broken bolts, and have the benefits derived from same been enough to overbalance the extra cost of flexible staybolts?" The discussion will be opened by Mr. T. A. Lawes.

Mr. T. A. Lawes: The cost of renewing 105 staybolts, in lots of six at a time, in one year on a certain engine, carrying 200 pounds of steam was $113.40. This includes taking down and putting up the parts of engine in the way of boiler makers; it also includes cost of blowing off engine, letting water out of boiler and filling same and cost of water. The cost of the same number of flexible staybolts, put in at one time, when engine was in back shop for repairs, was $94.50; no charge for stripping, as flexible staybolts were applied when new sheets were put in. From this it appears that the cost of flexible staybolts for the first year's service is $18.90 less than the same number of common staybolts. Now, if the same number of common staybolts break in the second year, we would save $113.40. However, since the side sheets of our engines carrying 200 pounds of steam, last but two years, flexible staybolts are renewed with side sheets, except that the brass sleeves and caps are used again with the new staybolts. So far as first cost is concerned, flexible staybolts are cheaper than common staybolts, when common staybolts are renewed in roundhouse in lots of six at a time.

The great advantage in the use of flexible staybolts is that the service of the engine is increased, since they do not break and engines are not held for renewal of bolts.

It is our rule to take out staybolts where six adjacent staybolts are broken. The loss of service of our engines under this rule, in one year, taking out 105 staybolts and renewing them, amounts to twelve days. In addition to labor and material this period also includes the time it takes to blow off steam, letting out water and cooling off boiler, so it can be worked in; also filling up the boiler, but not getting up steam.

It may be of interest to state that the greatest number of flexi-

ble staybolts we have used in one engine is 430; the least is 140. We have 27 engines equipped with these bolts — in all 5,280 flexible staybolts in use.

We use the flexible staybolts invented by Wehrenfennig, Chief Engineer of Material of the North-Eastern Railway of Austria, improved by W. Leach, Foreman Boiler Maker of one of the railways of India, and still further improved by the Pennsylvania Company; no doubt you are all familiar with this flexible staybolt, as it is used in great numbers by that company. The patents on this type of flexible staybolts have long since run out and they can be used by any one without royalty.

THE PRESIDENT: The subject is open for general discussion.

MR. GEORGE W. WEST: Did I correctly understand that it is necessary to remove the side sheets in two years on account of broken staybolts?

MR. LAWES: In two years our side sheets on engines carrying 200 pounds pressure.

MR. WEST: And that large number of staybolts were broken in one year?

MR. LAWES: One hundred and five staybolts were broken in one year on a passenger engine.

MR. WEST: We have a large number of wide fire box engines known as the Wootten type, though they do not have the Wootten patent; in other words, our flue sheets are straight. Eighty-five wide fire box engines had 3,202 broken staybolts from January 1, 1901, to December 1, 1901, a period of eleven months. The average number per engine was 38; average per month per engine, 3; 2,965 of the total 3,202 were from boilers that were from eight to eleven years in the service, and represented 56 of the 85 engines. The other 29 engines have been in service from one to six years, and only had 237 bolts broken. I think there was as much in the design of the boiler Mr. Lawes refers to as in the staybolts or water; that the trouble was as much with the boiler as anything else. I would state that we have several of these engines in service, and have had them for three years, and never had a staybolt broken. We never allow a single staybolt to remain in service after it is demonstrated that it is cracked or broken.

Mr. F. F. Gaines: I will say my experience has been, as Mr. West states, that the form of the fire box undoubtedly has something to do with the breaking of the staybolts. In hard service, with a certain type of wide fire box boiler, the life of staybolts was prolonged over one hundred per cent by altering the contour.

Mr. West: Our experience has been that the staybolts in the wide fire boxes crack, and we keep a correct record and have a print showing the location of every bolt removed in twelve years, and it is demonstrated that they start to crack very close to the mud ring, and each year or two creep up to the point where the staybolts were longer. I do not think we had a single staybolt broken, which was eight or ten inches long, until the engine had been in service five or ten years. I do not think we had a broken staybolt which was nine inches long.

Mr. P. H. Minshull: The first bolts we had break on the class of engines Mr. West speaks of, were in the throat sheet, then in the front and back corners on the side sheets. Then they worked toward the center and worked up. We have many fire boxes which have been in use for eleven years that have not had a staybolt broken that was more than nine inches long.

Mr. John Player: I would fully corroborate Mr. West in his statement that the type or design of the boiler has a great deal to do with the breaking of the staybolts. In our varied experience with different types of boilers and different designs of boilers, we frequently received reports of excessive breakage of staybolts in certain designs, and on comparing the different types of boilers on which the breakage of staybolts took place, this practical information is quite interesting. I think some action should be taken by the Association to improve the design of the fire box by increasing the water space and eliminating some of the existing curves in the narrow fire box engines, and in designing wide fire box engines with special reference to obtaining less breakage of staybolts by increasing the water space upon the sides, and spacing the staybolts in such manner as to eliminate the breakage.

I have in mind one particular design of boiler that we built several years ago, which, I felt sure, would give us very great breakage of staybolts, and my suspicions at that time were verified by the fact that at the present time they have a type of boiler

on the road for which these boilers were furnished, which are provided exclusively with flexible staybolts. We cannot keep the ordinary staybolts in place.

MR. E. W. PRATT: It occurs to me that the large number of staybolts removed in a year, as given by Mr. Lawes, may not be entirely due to the design of the boiler. I am inclined to think that if we should allow our boiler makers to not renew the broken staybolts until there were six adjacent staybolts broken, we would find a great many more staybolts renewed during the year than we do at the present time.

MR. GEORGE L. FOWLER: Has Mr. West used the flexible staybolts?

MR. WEST: Not to any extent. We fitted up one side of two fire boxes of the same type of engine, one on the right side and the other on the left side, and on the opposite side of each engine we placed the rigid bolts, but we have not had them in service long enough to pass any opinion.

THE PRESIDENT: I think it would be interesting, especially in view of the subject as it is set down, if we could hear some experience in regard to the use of flexible staybolts as compared with the ordinary staybolt.

MR. S. W. MILLER: We have used a great many flexible staybolts. They do sometimes break, but we find that the breakage is generally due to one of two causes. In the first place, the socket or ball-joint seat becomes filled with lime in bad water districts and makes practically a solid staybolt. In addition to that the boiler makers, if not watched carefully, will get the sleeves screwed into the boiler, so that the expansion of the sheet will make the staybolt bear against the inside edge of this socket, making the staybolt really shorter than it would be if an ordinary staybolt were used. We find that we have to watch that pretty closely.

THE PRESIDENT: Mr. Miller, it might be interesting if you have any data in regard to the comparative costs of maintaining boxes with the flexible staybolt as compared with boxes in similar service with the ordinary staybolt. Can you give us any such data?

Mr. Miller: I have no positive data here to give. From my experience they cost much less to maintain than the staybolts in ordinarily constructed fire boxes where the water space is not very wide. I saw on a prominent road not very long ago a boiler that was just having a fire box put in where the water space at the mud ring was three inches between the side sheets and the space at the top of the flue sheet was less than two inches.

Mr. George L. Fowler: I think it would be interesting to get some data in regard to the relative value of the three different kinds of flexible staybolts; one with the socket, the other, which is simply an elongation of the bolt (the bolt used by the Pennsylvania for a number of years), and finally the bolt referred to by Mr. Lawes, in which the bolt is made flexible by being cut away in the center, so that the diameter is less in the center than at the root of the thread. That distributes the stresses throughout the bolt, but makes the bend in the bolt itself, which is different from the flexible staybolt, as ordinarily understood, where it sits down in a socket and turns in that.

Mr. George W. West: I would ask to what extent these flexible staybolts have been used on the boilers mentioned, whether continuous on one side or put in at points where weak staybolts were discovered?

In passing through one of the large locomotive works connected with the American Locomotive Company, I noticed a boiler in which every other staybolt had been applied as a rigid bolt and the alternate bolts were flexible. It would seem to me that was a bad application and would necessarily make the rigid bolt do double the work of the flexible bolt. I would ask whether Mr. Miller had that experience?

Mr. Miller: A number of years ago we had a very general investigation of the breakages of staybolts. All classes of engines were taken and every staybolt that was broken was reported.

We found that the places where the staybolts broke varied in each type of engine, but was generally the same for the engines of each type. As a general proposition, the staybolts in the upper front and back corners of the fire box broke most frequently, so that we found it was advisable to make an application of the bolts in a triangular shape about five back and forward on the top row,

four or five in the front and back vertical rows, so that there would be probably twelve to fourteen flexible staybolts in the back and front top corners. In addition to that, we now drill every staybolt in the fire box as new ones are applied, drilling the bolts before they are put in, as we find that drilling them afterward is not reliable. In one case we tested the boiler five times after the staybolts were drilled from the outside, and each time we found more broken or cracked stay bolts. The holes were drilled partly through into the water space.

There is another matter which should receive attention and that is the quality of iron used in staybolts. I have been told that certain locomotives received from the manufacturers developed a great deal of trouble with broken staybolts, but after another kind of iron was put in, that the staybolt breakage was very much reduced.

Mr. West: I understand, then, you have no engines running with the entire side sheet fitted with flexible staybolts?

Mr. Miller: No, sir.

Mr. West: Has this application of the flexible bolt transmitted the strains to the other portions of the boiler, and possibly caused broken bolts in other portions of the boiler?

Mr. Miller: There is one class of engine in which we have the whole top row on each side sheet fitted with flexible staybolts, and that is the only class of engines in which the difficulty referred to has developed. The engine in question is rather narrow at the top of the fire box.

Mr. West: I think it is important to consider that point. If we are going to overcome a defect in one part of the boiler and transmit it to another part, there will be little to gain by the use of a flexible staybolt, and if anyone has had any experience in that line, I think it would be very interesting to hear from them.

Mr. T. A. Lawes: In closing the discussion I may say, briefly, that while we can build boilers in which the fire boxes are properly designed to prevent broken staybolts, the matter which concerns us most at the present time is to prevent the breaking of staybolts in the boilers already built. A portion of this discussion had reference to the Wootten type of fire box, burning anthracite coal, but the great majority of engines in use are those which burn

bituminous coal, with the fire box on top of the frame and of the narrow description; so do not let us be deceived by thinking we can build boilers and get rid of this trouble with staybolts. We must consider what we have to use at the present time.

As to the matter of six staybolts to be renewed at a time, we drill all our staybolts; when leakage appears at the hole in the staybolt we have some of the staybolt left, and we do not consider it dangerous. We have never had any trouble. It is a different proposition when they are broken off entirely, six at a time.

MR. MILLER: I want to say that it is important to watch the staybolts which are drilled. I have known of a number of cases where the trouble with the staybolt was in the cab, and the steam caused the engineer some inconvenience. It was a simple matter for him to drive a wire nail in these leaks to conceal any evidence of the leak.

MR. QUEREAU: I move that the discussion be closed.

The motion was carried.

THE SECRETARY: The following written discussion of the topical subject "Best Proportion of Grate Surface and Arrangement of Draft Appliances for Oil-Burning Locomotives" has been received:

H. J. SMALL (Southern Pacific Co.): While heating surface and sufficient fire-box volume for the purpose of proper combustion is just as essential in the oil-fuel locomotive as in the coal-burning locomotive, similarity in requirements to burn the two different kinds of fuel ceases there. Grate surface is of so little importance that it is not figured on for the oil-burning locomotive. In speaking of the oil-burner we will substitute "floor space" hereafter for "grate surface" mentioned in connection with coal-burning locomotives, and I will say that in the ordinary fire box of the oil-burning locomotives, floor space depends on conditions.

When converting coal-burning engines to oil and where the coal-burning engine's fire box was equipped with grate surface varying from twenty-five to fifty square feet, the floor space mentioned above, which we use in the oil-burner, may run from ten to twelve square feet, this depending on construction of ash pan, method of hanging engine on driving boxes, etc.

The admission of free air in certain quantities to the oil-burn-

ing fire box at suitable points does away with the consideration of grate surface. The floor space that I refer to is used as a means of properly locating the admission of the air. This is done by locating flash hole under arch. An opening seven inches wide by eighteen inches long will be suitable for engines varying in heating surface from 2,000 to 2,500 square feet. We also have an opening under the burner through the floor space five inches wide and sixteen inches long. To explain the floor space mentioned here (I will say that it is also sometimes called the inside pan), it is used for three different purposes: First, to properly locate air opening to furnace; second, to help flash the fuel oil as it passes from the burner to the flash wall. It answers this purpose because of its being lined with fire-brick which gets white hot and, again, it is used to start side walls from that we protect the fire box with.

To show here how little we figure on grate surface in the ordinary coal-burning fire box converted to burn oil, I will pass to the Morrison furnace used in Vanderbilt boilers, where we dispense with the consideration of grate surface altogether. We simply line the bottom of the Vanderbilt box with brick to serve the same purpose that the floor space or inside pan serves in connection with the ordinary boiler. We admit air to the Vanderbilt box by introducing a suitable framing in the man hole or foundation ring opening which we find in these boilers, and to regulate the admission of air through that framed opening we apply an air pan similar to the ash pan in the ordinary fire box. Consequently, while the heating surface in the present wide fire box is appreciated, the increased grate surface, which is so much appreciated in burning coal, is detrimental in the oil burner. It means more brick work to maintain, also poorer circulation in the leg or bottom of water space. For stayed fire boxes (radial or crown bar) the deep fire box is preferable for oil — that is, when they come within the range required in heating surface and in volume for proper combustion.

The Vanderbilt boiler now gives promise of being the ideal one for oil-burning in locomotive service. The poor circulation which gave trouble in Vanderbilt boilers used for coal is done away with, and with our method of burning oil the circulation is satisfactory while all of the other desirable features are retained.

Respecting draft appliances in the front end: Our practice has been to arrange a stand or exhaust pipe that would bring top of

nozzle in center of smoke arch and use draft or petticoat pipe, which gives an inch clearance over the top of nozzle and 4½ inches at top of arch. We are now experimenting with a still shorter standpipe and sectional petticoat pipe which promises to give a better equalization of draft through all the tubes.

THE PRESIDENT: If no member has any other business to propose, we will now proceed to the election of officers. This year we have the unusual situation of being required to elect three Vice-presidents; two of our Vice-presidents having taken higher positions in the operating department which will prevent them from serving with us. Sometimes we do not remember, from year to year, what the sentiment of the Association in the previous year has been. I thought it not out of place, as I was looking over the Proceedings of last year, to note the names of the members who received more than an ordinary one vote for Vice-president last year. I do not do this with a view of suggesting or pointing out who should be elected, but merely sometimes you want to know who was voted on last year. I note in the report of the tellers last year for the office of third Vice-president that the ballots which were cast for those who received more than one vote were for Messrs. F. A. Delano, W. H. Lewis, P. H. Peck and Mord Roberts.

The provision for the election of officers is that they shall be elected separately, without nomination; elected by ballot. I will appoint Mr. Vaughan and Mr. Clark as tellers. The tellers will please distribute the ballots for President.

The tellers reported that 38 votes were cast for President, as follows: George W. West, 35; A. M. Waitt, 2; H. F. Ball, 1.

On motion the Secretary was authorized to cast the unanimous ballot of the convention for Mr. West.

Mr. West was declared elected.

PRESIDENT WAITT: I want to say in handing the gavel to Mr. West that I thank you all very much for the hearty coöperation and support which you have given me and for the very active way in which you have all taken part in the work of the Association, which has made it a success and made it easy for me as the presiding officer. I know you will give Mr. West the same support and aid the coming year that you have given me. I introduce Mr. West, your new president.

PRESIDENT-ELECT WEST: I want to express my appreciation of the honor you have conferred upon me. Little did I think, twenty-two years ago, when I was made a member of this Association, that the honor of being its president would ever come to me. I think, in looking over the list of men who have so ably presided over your deliberations and we consider how well and successfully the work has been done by this Association, it should prompt us to consider well whom we select as its officers. The past year has seen many changes in methods in railway work and in the advancement of men, especially from the department which we represent, and I think the Association and its members have been recognized in the past year to a greater extent, possibly, than in the past ten years, and we cannot be too careful whom we shall select as our officers, as it has become almost the standard with this Association that we shall promote our Vice-presidents from the third Vice-presidency to the second Vice-presidency, and so on to the office of President. I thank you for this election and hope the success of the coming administration will be as great as that of the past administration.

PROFESSOR GOSS: Mr. President, during the convention now closing, we have been delighted to be obedient to the firm and courteous control of our retiring President. His rule has been just and his administration most energetic. I move that we express by a rising vote our appreciation of the services rendered the Association by Mr. Waitt, its presiding officer.

The motion was unanimously carried.

The ballot was then taken for first Vice-president. The tellers reported 37 votes cast, as follows: W. H. Lewis, 24; P. H. Peck, 7; H. F. Ball, 2; and the following gentlemen each one: O. Stewart, William McIntosh, Mord Roberts, C. H. Quereau.

On motion the election of Mr. Lewis was made unanimous.

THE PRESIDENT: I will say for the information of those members not acquainted with the fact, that it was necessary for Mr. Lewis, who has just been elected first Vice-president, to absent himself to-day, as he was called north.

On the ballot for second Vice-president the tellers reported 39 votes cast, as follows: P. H. Peck, 21; H. F. Ball, 6; C. H. Quereau, 3; F. H. Clark, 2; and the following gentlemen each

one: C. A. Seley, William McIntosh, Mord Roberts, George A. Hancock, George R. Henderson, R. D. Smith, A. E. Mitchell.

On motion the election of Mr. Peck was made unanimous.

MR. P. H. PECK: I will say, gentlemen, that I have been a member of the Association for sixteen years, and worked hard for the Association in my way the best I could; and I guarantee the members of the Association that my labors will now be redoubled. I hope the members will have no cause to regret electing me as second Vice-president.

On the ballot for third Vice-president the tellers reported 35 votes cast, as follows: H. F. Ball, 10; C. H. Quereau, 8; William McIntosh, 7; R. D. Smith, 3; F. H. Clark, 2; and the following gentlemen each one: George R. Henderson, H. H. Vaughan, Angus Sinclair, A. E. Mitchell and C. A. Seley.

There being no election, a second ballot was taken, and the tellers reported 40 votes cast, as follows: H. F. Ball, 23; C. H. Quereau, 11; William McIntosh, 3; F. H. Clark, 2; and Angus Sinclair, 1.

On motion the election of Mr. Ball was made unanimous.

THE PRESIDENT: It is now in order to elect the Treasurer.

On the ballot for Treasurer the tellers reported 37 votes, as follows: Angus Sinclair, 32; A. M. Waitt, 3; G. M. Basford, 1; O. Stewart, 1.

On motion the election of Mr. Sinclair was made unanimous.

MR. SINCLAIR: Mr. President, the time for speeches to-day is over. I think the most eloquent thing I can say is that I thank you for your confidence.

The convention then adjourned.

STANDARDS ADOPTED BY THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

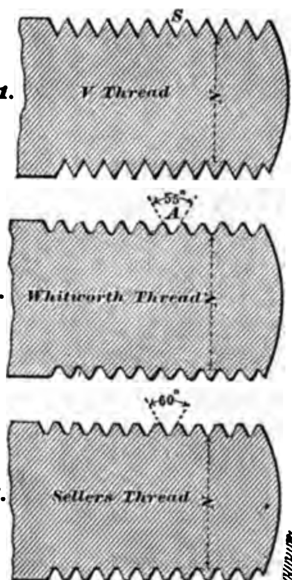
SCREW THREADS.

At the convention of 1870 the report of a committee recommending the United States Standard Screw Thread was adopted. The forms and dimensions of the threads are shown below:

Fig. 1.

Fig. 3.

Fig. 5.

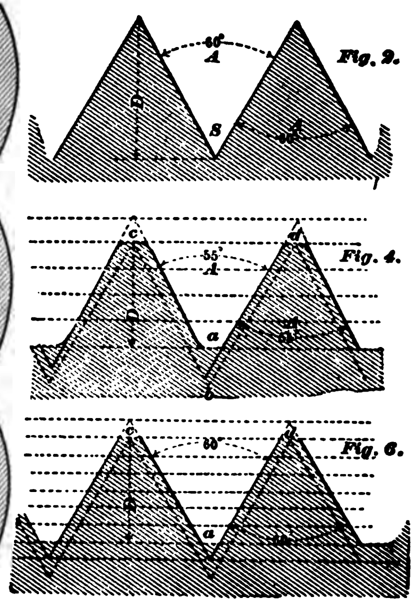


SCREW THREADS.

Fig. 2.

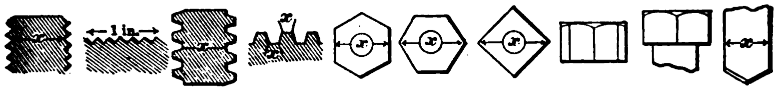
Fig. 4.

Fig. 6.



SELLERS' STANDARD.

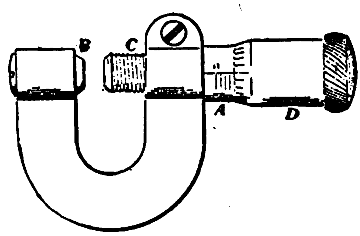
At the convention of 1892 the Association adopted as standard the United States standard sizes of nuts and bolt heads as follows:



Diameter of Screw.	Threads per inch.	Diameter at Root of Thread.	Width of Flat.	Short Diameter of Hexagon or Square.	Long Diameter Hexagon.	Long Diameter Square.	Thickness Nuts.	Thickness Heads.	Tap Dri l.
1/4	20	.185	.0062	1/2	37/64	7/10	1/4	1/4	3/16
5/16	18	.240	.0074	19/32	11/16	10/12	5/16	19/64	1/4
3/8	16	.294	.0078	11/16	51/64	63/64	3/8	11/32	5/16
7/16	14	.344	.0089	25/32	9/10	1 7/64	7/16	25/64	23/64
1/2	13	.400	.0096	7/8	1	1 15/64	1/2	7/16	13/32
9/16	12	.454	.0104	31/32	1 1/8	1 23/64	9/16	31/64	15/32
5/8	11	.507	.0113	1 1/16	1 7/32	1 1/2	5/8	17/32	17/32
3/4	10	.620	.0125	1 1/4	1 7/16	1 49/64	3/4	5/8	5/8
7/8	9	.731	.0138	1 7/16	1 21/32	2 1/32	7/8	23/32	3/4
1	8	.837	.0156	1 5/8	1 7/8	2 19/64	1	13/16	27/32
1 1/8	7	.940	.0178	1 13/16	2 3/32	2 9/16	1 1/8	29/32	31/32
1 1/4	7	1.065	.0178	2	2 5/16	2 53/64	1 1/4	1	1 3/32
1 3/8	6	1.160	.0208	2 3/16	2 17/32	3 3/32	1 3/8	1 3/32	1 3/16
1 1/2	6	1.284	.0208	2 3/8	2 3/4	3 23/64	1 1/2	1 3/16	1 9/32
1 5/8	5 1/2	1.389	.0227	2 9/16	2 31/32	3 5/8	1 5/8	1 9/32	1 13/32
1 3/4	5	1.491	.0250	2 3/4	3 3/16	3 57/64	1 3/4	1 3/8	1 1/2
1 7/8	5	1.616	.0250	2 15/16	3 13/32	4 5/32	1 7/8	1 15/32	1 5/8
2	4 1/2	1.712	.0277	3 1/8	3 5/8	4 27/64	2	1 9/16	1 3/4
2 1/4	4 1/2	1.962	.0277	3 1/2	4 1/16	4 61/64	2 1/4	1 3/4	1 31/32
2 1/2	4	2.176	.0312	3 7/8	4 1/2	5 31/64	2 1/2	1 15/16	2 3/16
2 3/4	4	2.426	.0312	4 1/4	4 29/32	6	2 3/4	2 1/8	2 7/16
3	3 1/2	2.629	.0357	4 5/8	5 3/8	6 17/32	3	2 5/16	2 5/8
3 1/4	3 1/2	2.879	.0357	5	5 13/16	7 1/16	3 1/4	2 1/2	2 29/32
3 1/2	3 1/4	3.100	.0384	5 3/8	6 7/64	7 39/64	3 1/2	2 11/16	3 1/32
3 3/4	3	3.317	.0413	5 3/4	6 21/32	8 1/8	3 3/4	2 7/8	3 11/32
4	3	3.567	.0413	6 1/8	7 3/32	8 41/64	4	3 1/16	3 19/32
4 1/4	2 7/8	3.798	.0435	6 1/2	7 9/16	9 3/16	4 1/4	3 1/4	3 13/16
4 1/2	2 3/4	4.028	.0454	6 7/8	7 31/32	9 3/4	4 1/2	3 7/16	4 1/32
4 3/4	2 5/8	4.256	.0476	7 1/4	8 13/32	10 1/4	4 3/4	3 5/8	4 9/32
5	2 1/2	4.480	.0500	7 5/8	8 27/32	10 49/64	5	3 13/16	4 1/2
5 1/4	2 1/2	4.730	.0500	8	9 9/32	11 23/64	5 1/4	4	4 3/4
5 1/2	2 3/8	4.953	.0526	8 3/8	9 23/32	11 7/8	5 1/2	4 3/16	4 31/32
5 3/4	2 3/8	5.203	.0526	8 3/4	10 5/32	12 3/8	5 3/4	4 3/8	5 7/32
6	2 1/4	5.423	.0555	9 1/8	10 19/32	12 15/16	6	4 9/16	5 7/16

SHEET METAL GAUGE.

At the convention of 1882 the Brown & Sharpe micrometer gauge shown below was adopted as standard for the measurement of sheet metal (see page 132, report 1882). Reaffirmed 1891 (see pages 160, 161, report 1891).



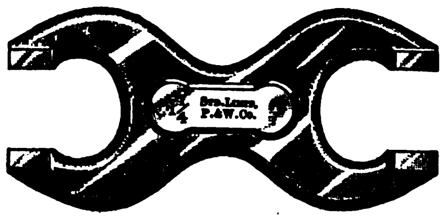
DISTANCE BETWEEN BACKS OF FLANGES.

At the convention of 1884 a motion prevailed that the standard distance between the backs of tires for tender locomotive truck and driving wheels be not less than 4 feet 5¼ inches, nor more than 4 feet 5½ inches. (See page 26, report 1884.)

LIMIT GAUGES FOR ROUND IRON.

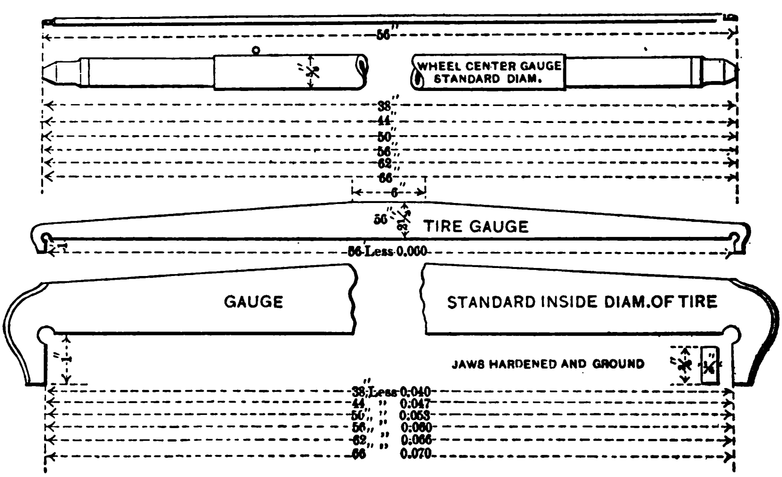
At the convention of 1884 the Pratt & Whitney limit gauges for round iron, shown below, were adopted as standard. (See page 168, report 1884.) Reaffirmed 1891 (see pages 160, 161, report 1891).

Nominal Diameter. Of Iron. Inches.	Large Size, End. Inches.	Small Size, End. Inches.	Total Variation. Inches.
¼	.2550	.2450	.010
5/16	.3180	.3070	.011
⅜	.3810	.3690	.012
7/16	.4440	.4310	.013
½	.5070	.4930	.014
9/16	.5700	.5550	.015
⅝	.6330	.6170	.016
¾	.7585	.7415	.017
⅞	.8840	.8660	.018
1	1.0095	.9905	.019
1 ⅛	1.1350	1.1150	.020
1 ¼	1.2605	1.2395	.021



DRIVING WHEEL CENTERS AND SIZES OF TIRES.

At the convention of 1886 the report of a committee was adopted which recommended driving-wheel centers to be made 38, 44, 50, 56, 62 or 66 inches diameter. At the Twentieth Annual Convention the recommendations of a committee were adopted, making tire gauges manufactured by Messrs. Pratt & Whitney, Hartford, Connecticut, and here illustrated, standards of the Association. The sizes and the allowance for shrinkage are as follows:

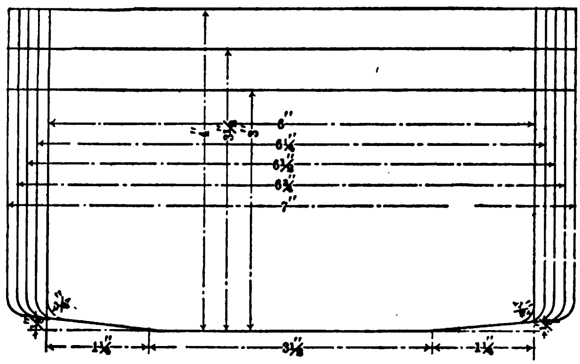


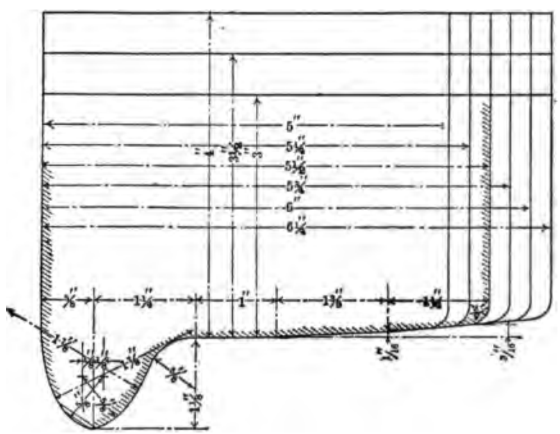
At the Twenty-sixth Annual Convention the following sizes were adopted as standards for large driving wheels: 70, 74, 78, 82, 86 and 90 inches.

Reaffirmed in 1891 (see pages 160, 161, report 1891).

SECTION OF TIRE.

At the convention of 1893 the standard forms of tires shown in the annexed engraving were adopted as standard. Railroad companies ordering tires will save time by specifying these forms.





At the convention of 1896 a minimum thickness of 1 inch for the flanges of engine and truck wheels was adopted as standard practice; determination to be made by M. C. B. flange thickness gauge. (See Proceedings for 1896.)

BOILER AND FIRE-BOX STEEL SPECIFICATIONS.

Adopted in 1894. (See pages 68-92, report 1894.)

Special Requirements for Sheet Steel.

Tensile strength, 55,000 pounds to 65,000 pounds. Elongation not less than 20 per cent in 8 inches.

Test piece after having rough edges removed by filing, grinding or machining shall, without annealing, bend over on itself, both while cold and after being heated to cherry red and dipped in water at 80 degrees Fahrenheit, without showing cracks or flaws on outside edge.

No chemical requirements.

Special Requirements for Fire-box Steel.

Metal to have tensile strength of from 55,000 pounds to 65,000 pounds, with 60,000 pounds desired; elongation, 28 per cent.

Chemical Requirements.

Carbon	.18 per cent
Phosphorus, not above........................	.03 per cent
Manganese, not above.........................	.40 per cent
Sulphur, not above............................	.02 per cent
Silicon, not above.............................	.02 per cent

Plates will be rejected having:

1. Tensile strength less than 55,000 pounds.
2. Tensile strength over 65,000 pounds.
3. Elongation less than 22 per cent in 8 inches, and in ¼-inch plates not less than 20 per cent in 8 inches.
4. Failure to stand bending and quenching test as for sheet steel.
5. Any seam or cavity more than ¼ inch long in any of the fractures of homogeneity test.
6. Carbon, over .25 per cent.
7. Carbon, below .15 per cent.
8. Phosphorus, over .035 per cent.
9. Manganese, over .45 per cent.
10. Silicon, over .03 per cent.
11. Sulphur, over .035 per cent.

Homogeneity Test.

A portion of the broken test piece should be nicked with chisel on opposite sides alternately, the nicks being about 1 inch apart. Test piece should then be firmly held in vise and broken by a number of light blows, the bending being away from the nicks. Laminations more than ¼ inch long will condemn.

Test Pieces.

Test pieces, one from each plate, shall be in rough, 2 inches wide and 36 inches long, and as nearly straight and free from twist as possible, and in no case must be annealed. Each plate shall bear the maker's name, either rolled or stamped. The heat number and, in addition, such identification marks as may be specified by ordering road, shall be put on each plate and test piece.

When inspectors are present at mills, butt strips may be cut from any plate, provided such sheets are represented by test coupons. Where

inspectors are not at mills, they must, as far as possible, be cut from a single sheet as rolled, and each sheet cut into butt strips will be represented by a test strip. All butt strips as well as test strips shall bear the heat number.

Shear Marks.

Each sheet shall be accompanied by a test coupon, 2 by 36 inches long, attached at one end to sheet. To facilitate future matching, should it be necessary, both sheet and coupon shall be stamped twice across division line with a shear mark, either round, oval or of other agreed form, which mark should be not less than 3 inches across.

In cases where one large plate is cut into several smaller ones, all represented by one test piece, the same shear mark shall be stamped across each division line in two places before shearing, so that subsequent identification may be readily performed.

Dimensions.

Plates must be of shape and dimensions ordered. Any excess in weight over that corresponding to the dimensions in the order, greater than that specified in the table below, will not be paid for.

In computing weight of plate from dimensions, one cubic inch will be taken as weighing 0.2836 of a pound.

Allowance for overweight over that corresponding to dimensions:

For plates	¼	inch	thick	10	per cent.
"	5/16	"	"	8	"
"	⅜	"	"	7	"
"	7/16	"	"	6	"
"	½	"	"	5	"
"	9/16	"	"	4½	"
"	⅝	"	"	4	"

Plates measuring 1-100 of an inch less in thinnest part than that ordered, and all plates which show seams or cracks at the sheared edges, or which have cracks, slivers or depressions in the surface, or which develop defects in working, will be rejected. Rejection on account of thinness is to be made only after measurement of the actual sheet. Test pieces being prepared from the edge of sheet are liable to be thinner than the main sheet.

Test pieces when finished will be 1½ inches wide in test section, and of full thickness of plate, and may be either parallel sided or of reduced section, and prepared either by longitudinal planing or milling. Where reduced section is adopted, the distance between bottom of fillets shall be not less than 9 inches, and the radius of fillets shall be not less than ½ inch, and preferably more.

Elongation will be measured between tram punch marks originally 8 inches apart, and on reduced sections placed approximately equidistant

between fillets. In parallel sided sections the tram punch may be applied at more than one point to insure breakage occurring between the marks.

STANDARD METHOD OF CONDUCTING EFFICIENCY TESTS OF LOCOMOTIVES.

In 1894 a method of conducting tests of locomotives was submitted by a committee of the Association, and on motion adopted as a standard of the Association. (See page 200, report 1894.)

The tests are as follows:

*A. Preparations for Test and Location of Instruments.**

1. The locomotive should be put in good condition preparatory to the test. The boiler and tubes should be tight, and both the interior and exterior surfaces should be clean, and, if possible, free from scale. There should be no lost motion in the valve gear, and the valves should be set properly. No change in the engines should be allowed during the progress of a series of tests, unless so ordered for the purposes of the trial.

A glass water-gauge should be fitted to the boiler, if not already provided, and side of it there should be a graduated scale to assist in correcting water quantities, caused by change of inclination of the boiler, and difference of levels when beginning and ending a test. The notches on the quadrant should be marked by large figures, so that they can be read by the cab assistant. The throttle valve lever should be provided with a scale so as to show the degree of opening of the throttle valve.

The point of cut-off of the valves should be determined for each notch in the quadrant.†

2. The valves and pistons should be tested for leakage with the engine at rest. The steam valve can be tried by setting the engine so that the valve on one side will be at the center of its throw, in which position both ports are usually covered, and pulling open the throttle valve, blocking the drivers if there is a tendency for the engine to be set in motion. Leakage of the valve, if any occurs, will show itself by escaping at the open cylinder cocks. The tightness of the piston may be tested by setting the engine so that it makes steam, blocking the drivers and opening the throttle valve. This should be tried first on one cylinder and then on the other, and, if desired, it may be tried with the pistons at various points in the stroke. The leakage, if any occurs, will be shown at the open cylinder cock.

3. The following instruments should be verified or calibrated: Steam gauges, draft gauge, pyrometer, thermometers for calorimeter and feed water, water meter, tank, revolution counter, indicator springs, dynamometer springs and dynamometer recording mechanism. The radiation loss

* The directions here given apply largely to both shop and road tests, but especially the latter.

† See appendix for description of valve diagram apparatus used on Norfolk & Western Railway.

on the steam calorimeter should be determined, or the normal readings ascertained,* and the quantity of steam which passes through the instrument in a given time should be measured.

4. The quantities of steam used by the various auxiliaries of the locomotive can be determined by noting the change in weight of the engine standing upon scales while they are each in use under the usual conditions for known times. Similarly leakage of water and steam can be determined. The quantities can then be properly deducted from the total water used.

5. To facilitate the measurement of coal and the determination of the quantity used during any desired period of the run, it is desirable to provide a sufficient number of sacks of a size holding a weight of, say, 100 pounds, and weigh the coal into these sacks preparatory to starting on the test. If desired, the sacks may be numbered to facilitate the accuracy of record.

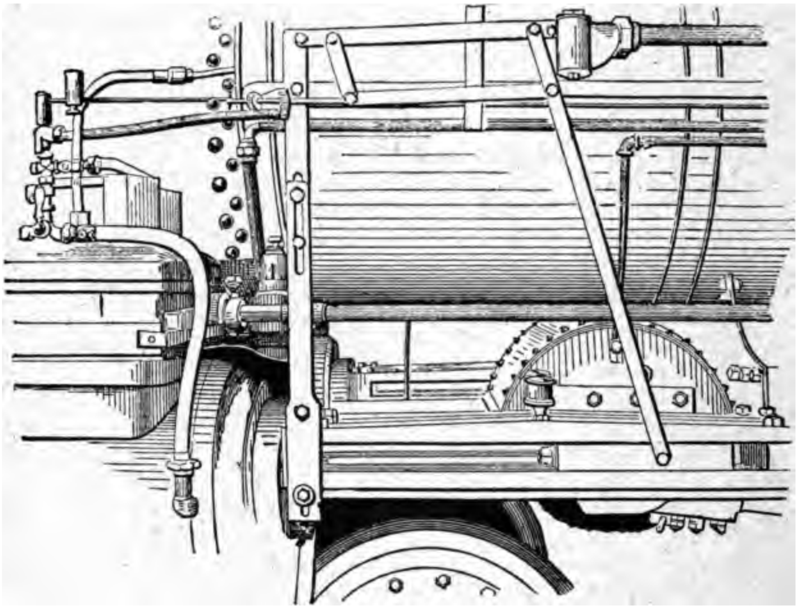
6. The instruments and other apparatus that should be provided and their locations are as follows:

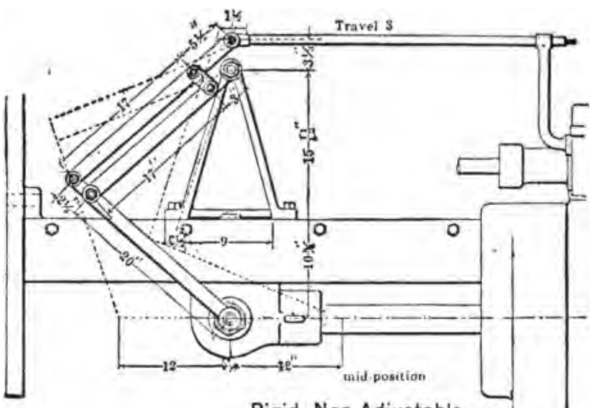
To facilitate the work of operating the indicators and reading the instruments at the front end, the smoke-box should be surrounded with a wooden fence, or "pilot-box," as it may be called, resting on the top of the cow-catcher, and extending back far enough to inclose also the sides of the cylinders. This box is floored over above the cylinder heads, and the inclosure thus provided forms a convenient place for the accommodation of the assistants at this end of the locomotive, and it affords them some measure of protection against wind and rain, as also the joltings and vibrations due to rapid travel.

A special steam-gauge with a long siphon is to be used for registering the boiler pressure. It can best be located on the left-hand side of the cab.

The indicator apparatus which is most suitable consists of a three-way cock for the attachment of the indicators, and some form of pantagraph or other correct reducing motion for the driving rig. The pipes leading from the cock to the cylinder should be ¾ inch diameter inside, and they should connect into the side of the cylinder rather than into the two heads. The indicator should also be piped so that a steam-chest diagram can be drawn by it, and from this the steam-chest pressure determined. Sharp bends in the pipe should be avoided, and they should be well covered, to intercept radiation. The three-way cock should be provided with a clamp rigidly secured to the cylinder, and thus overcome any tendency of the indicators to move longitudinally with reference to the driving rig. Absolute rigidity is highly essential in this particular. Two forms of pantagraph motion are shown in Figs. 1 and 2. In both of these the reduced motion is transmitted to the indicator through a light rod, working horizontally. By this means a cord eight or ten inches in length is sufficient for connection to the indicator. Care should be taken to set the instrument in such a position that the cord pin in the end of the rod

* Transactions A. S. M. E., Vol. XI, page 793.





Rigid Non Adjustable

travels in a direction pointing to the groove in the paper drum. Pantagraph motions arranged as noted are preferable to the common pendulum and quadrant reducing mechanism, with its long stretch of cord. For another type of correct reducing motion see appendix.

A draught gauge consisting of a U tube containing water, properly graduated in inches, should be placed in the cab and connected to the smoke-box by a ⅜-inch pipe. This long pipe steadies the water, and the readings can be taken by the cab assistant.

A pyrometer for showing the temperature of the escaping gases should be used in a position below the tip of the exhaust nozzles.

The calorimeter should be attached either to the steam dome at a point close to the throttle opening or to the steam passages in the saddle casting on one side, according as it is desired to obtain the character of the steam at one point or the other. The former location is preferred by the committee. A perforated ½-inch pipe should be used for sampling and conveying the steam to the calorimeter pipe. For descriptions of various forms of calorimeters which are adapted to locomotive use, see Trans. A. S. M. E., Vol. X, page 327; Vol. XI, page 790; Vol. XII, page 825.

The water meter should be attached to the suction pipe of the injector, and located at a point where it can be conveniently read when the locomotive is running. It should be provided with a check valve to prevent hot water from flowing back to it from the injector and a strainer to intercept foreign material.

To measure the depth of the water in the tank a metallic float should be used carrying a vertical tube which slides upon a graduated rod, the lower end of which rests upon the bottom of the tank. This should be placed at the center of gravity of the water space. If the desired location cannot be used, provision should be made for ascertaining the level or inclination of the tank. The best device for this purpose is a plumb line of a certain known length, provided at the bottom with a double horizontal scale having one set of divisions parallel to the side of the tank and the other set at right angles to it. From the readings on these scales referred to, the length of the line, the level of the tank in both directions can be ascertained. A similar device should be attached to the boiler to correct for the variation of its inclination.* The plumb line may be conveniently attached for this purpose at some point near the front end.

The revolution counter should be placed near the front end of the engine, in plain view of the pilot-box. It is operated through a belt from the driver axle. This recommendation applies to that form of counter which shows at a glance the exact speed in revolutions per minute.

A stroke counter should be provided for showing the number of strokes made by the air-pump.

Electric connection should be made between the dynamometer car

* See appendix for description of special devices used on the Norfolk & Western Railway for this purpose.

and cab, so that dynamometer records and indicator diagrams may be taken simultaneously. Another desirable provision is a speaking-tube leading from the dynamometer car to the locomotive cab, and one also to the pilot-box.

7. It is needless, except for a complete record of directions for preparatory work, to call attention to the desirability of having the test, and especially the road test, made under the supervision of a competent person, who is not only familiar with the details of the testing, but also with the proper method of firing and mechanical operation of the locomotive. This is a most important factor, for it is only the clear-headed and able experimenter who is likely to obtain satisfactory work in this most difficult department of engineering tests.

The conductor of the test is best able to determine the number of assistants required, the various duties of the men, and the manner of making records. In general, three (3) men are sufficient to conduct a locomotive test, one (1) being at each cylinder, and one (1) in the cab for taking records.

The men at the cylinders will take indicator diagrams, and one will read the revolution counter and the pyrometer. The indicator papers will be numbered in consecutive order for each cylinder before the test begins, and when the diagram is taken the papers will be deposited through a slot in a box near each assistant.

The cab assistant notes the time of leaving and arriving at stations, the position and time of opening and closing the throttle, the time of taking indicator diagrams, for which he shall determine the time and give the signal by any effective means; the time of blowing off, the time the blower is applied, the number of applications of the injector, the position of the reverse lever, the steam pressure, the draught gauge, the time of passing important stations, the readings of the water glass, meter and air-pump counter, the number of sacks of coal used, the reading of the tank float, the temperature of the feed-water and atmosphere, the direction and force of the wind, the condition of the rail and state of the weather. Many of these readings are as nearly as possible simultaneous with the signal for taking indicator diagrams, and one experienced man in the cab will have no difficulty in entering all of these records in a note-book properly prepared with ruled columns and headings. In case of short stops at stations, one of the men at the indicators can take the tank float observations, or any observation that is advisable at stations. The weights of coal placed upon the tender have been checked by these two persons when weighing it out to the engine. One man takes the level of the boiler at stopping-places where this is required.

When the calorimeter and smoke-box gas samples are used another assistant is required.

In the dynamometer car two (2) men are required, who record the time of each start and stop, the time of passing each station and mile-post, time of taking each indicator diagram as obtained from the signal given

by the cab assistant, and all these events are marked on the dynamometer paper. These men, as well as one of the engine assistants, will note the direction and force of the wind, the temperature of the atmosphere and condition of the weather.

8. It is of great importance, after the preparatory work has been accomplished, that a preliminary run be made with the locomotive, in order to fairly test the apparatus and to accustom the men to their duties.

B. The Dynamometer Car.

With a suitable dynamometer car the force required to move the train, or the pull upon the drawbar, is registered upon a strip of paper traveling at a definite rate per mile. The scale upon which this diagram is drawn should be as large as is possible within reasonable limits. A scale of ¼ inch per 1,000 pounds pull is suitable, as the maximum registered pull rarely exceeds 30,000 pounds.

The height of the diagram should be measured from a base line drawn upon the paper by a stationary pen, so located that when no force is exerted upon the drawbar the base line should coincide with zero pull.

The apparatus should be arranged to make a record of time marks in connection with the curve showing the pull. A chronometer should be provided having an electric circuit-breaker, by means of which a mark is made on the dynamometer paper every five (5) seconds. A better apparatus may be used in which a continuous speed curve is traced upon the paper parallel to the curve of pull. The ordinates of this curve, measured from a base line, give the speeds desired.

The location of mile-posts and other points along the route should be fixed upon the dynamometer paper by employing an additional pen, and operating it by means of electric press buttons, which are placed at convenient points in the car.

As already noted, a similar device should be provided for marking upon the dynamometer paper the time of taking indicator diagrams.

The rate of travel of the paper per mile should be such that one inch measured upon the diagrams represents 100 feet for short-distance work, and for long-distance work ½ inch to ¼ inch should be used to represent 100 feet of track. The driving mechanism for the paper should be so arranged that it can be changed to give these three proportions. It is necessary to have all the registering pens located upon the same transverse line at a right angle with the direction of the movement of the paper in order that simultaneous data may be recorded.

C. Method of Conducting the Road Test.

The locomotive having been brought to the train, the steam pressure being at or near the working point, the fire being clean and in good condition, the ash-pan being also clean, observations are taken, say, five (5) minutes before starting time, of the thickness and condition of the fire, the height of water in the boiler, the depth in the tank, the levels, the water

meter and the air-pump counter, and thereafter the regular observations are carried forward, and coal is fired from the weighed sacks.

Indicator diagrams should be taken as frequently as possible, the intervals between them being not over two minutes.

Other regular observations should be taken at close intervals. Calorimeter readings, when taken, should be continued for at least five (5) minutes at one minute intervals.

At water stations careful records should be obtained of water heights and levels of boiler and tank.

As the end of the route is approached, the fire should be burned down so as to leave the same amount and the same condition as at the start. When the end is finally reached the fire should be raked and its condition carefully noted. If it differs from that which obtained at the beginning, an estimated allowance must be made for such difference.

At the close of the test the height of water in the boiler should be the same as at the beginning, or, if not, the difference, corrected for inclination of the boiler, should be allowed for.

During the process of weighing the coal into the sacks numerous samples should be obtained and placed in a covered box, and a final sample of these selected. This is to be dried and subjected to chemical analysis and calorimeter test. The sample is weighed before and after drying, and data obtained for determining the weight of dry coal used during the test. The temperature of the feed-water can be best taken at the tank cock, in order to obtain that of a mixed sample.

The duration of the road test is the length of time which the throttle valve is open.

D. The Data and Results.

The data and results of the road test may be tabulated in the form given in Table No. 1. This form corresponds in general with that recommended for shop test, namely, Table No. 1.

TABLE No.

Data and Results of Road Test on [illegible] Engine, [illegible] 189 .

General dimensions, etc. (to be accompanied by a complete description of engine with drawings and dimensions, [illegible] road and route):

1. Kind of engine ....
2. Size of cylinders ....
3. Clearance of cylinders ......per cent
4. Area of heating surface ......sq. ft.
5. Area of grate surface ......sq. ft.
6. Size of exhaust nozzles ......inches
7. Average weight of [illegible] and tender (including water) ....tons
8. Number of cars ....
9. Weight of cars ......tons

10. Length of route ....miles
11. Number of ton-miles of train load ....ton-miles
12. Number of ton-miles of total load.......................ton-miles
13. Schedule time of trips..

Total Quantities.

14. Duration or time throttle valve is open ....hours
15. Weight of dry coal burned ....lbs.
16. Weight of water exaporated corrected for moisture in the steam and loss at injector*..................................lbs.
17. Weight of ashes and refuse taken from ash-pan..................lbs.
18. Weight of cinders from smoke-box ....lbs.
19. Percentage of ash as found by coal calorimeter test..........per cent
20. Total heat of combustion as found by calorimeter test ....B. T. U.
21. Results of chemical analysis of coal ....

Power Data.

22. Mean effective pressure, H. P. cyls.............................lbs.
23. Mean effective pressure, L. P. cyls............................lbs.
24. Average revolutions per minute..............................rev.
25. Indicated horse-power, H. P. cyls..........................H. P.
26. Indicated horse-power, L. P. cyls...........................H. P.
27. Indicated horse-power, whole engine........................H. P.
28. Pull on drawbar..lbs.
29. Dynamometer horse-power ....H. P.

Averages of Observations of Instruments.

30. Average boiler pressure ....lbs.
31. Average steam-chest pressure ....lbs.
32. Average temperature of smoke-box........................... °
33. Average drought suction.. "
34. Average temperature of feed-water............................. °
35. Average temperature of atmosphere.......................... °
36. Average percentage of moisture in the steam.................per cent
37. Maximum percentage of moisture in the steam.............per cent
38. Weather, wind, etc..

Other Data.

39. Average position of throttle..
40. Average position of reversing lever...............................
41. Average speed in miles per hour.....................................
42. Maximum speed in miles per hour..................................
43. Number of stops...
44. Average number of strokes of air pump per minute................

* Should be corrected for steam used by calorimeter, air pump, blower, safety valve and whistle, to find cylinder results — line 56.

45. Total estimated weight of steam used by air pump per hour......lbs.
46. Estimated loss of steam at safety valve per hour..................lbs.
47. Estimated loss of steam at whistle per hour.....................lbs.
48. Estimated weight of steam used by blower per hour...............lbs.
49. Estimated loss of steam at calorimeter per hour..................lbs.

Hourly Quantities.

50. Weight of dry coal burned per hour.............................lbs.
51. Weight of dry coal burned per hour per square foot of grate surface ....lbs.
52. Weight of coal burned per square foot of heating surface........lbs.
53. Weight of water evaporated per hour..........................lbs.
54. Equivalent weight of water evaporated per hour with feed-water at 100° and pressure 70 lbs..........................lbs.
55. Equivalent weight of water from 100° at 70 lbs. evaporated per square foot of heating surface..........................lbs.
56. Weight of water consumed by engine cylinder (line 53, less sum of lines 45, 46, 47, 48 and 49)..........................lbs.

Principal Results — Complete Engine and Boiler.

57. Coal consumed per I. H. P. per hour............................lbs.
58. Coal consumed per dynamometer horse-power per hour............lbs.
59. Coal consumed per ton-mile of train load.......................lbs.
60. Coal consumed per ton-mile of total load.......................lbs.
61. Weight of standard coal consumed per I. H. P. per hour.........lbs.
62. Weight of standard coal consumed per dynamometer horse-power per hour...lbs.
63. Weight of standard coal consumed per ton-mile of train load....lbs.
64. Weight of standard coal consumed per ton-mile of total load.....lbs.

Boiler Results.

65. Water evaporated per pound of coal ....lbs.
66. Equivalent evaporation per pound of coal from and at 212°......lbs.
67. Equivalent evaporation per pound of combustible from and at 212° ....lbs.
68. Heat imparted to each pound of steam used from average temperature of feed at average steam pressure in British thermal units..

Cylinder Data.

69. Mean initial pressure above atmosphere.........................lbs.

	H. P. Cyl.	L. P. Cyl.
70. Cut-off pressure above zero..............lbs.	......	......
71. Release pressure above zero ....lbs.	......	......
72. Compression pressure above zero..........lbs.	......	......

		H. P. Cyl.	L. P. Cyl.
73.	Lowest back pressure above or below atmosphere ....lbs.	......	......
74.	Proportion of forward stroke completed at cut-off	......	......
75.	Proportion of forward stroke completed at release	......	......
76.	Proportion of return stroke uncompleted at compression	......	......
77.	Mean effective pressure (lines 22 and 23) lbs.	......	......

Cylinder Results.

78. Total water consumed per indicated horse-power per hour, corrected for moisture in steam..............................lbs.

79. Water consumed per I. H. P. per hour by cylinders alone (from line 56)..............................lbs.

		H. P. Cyl.	L. P. Cyl.
80.	Steam accounted for by indicators at cut-off.lbs.	......	......
81.	Steam accounted for by indicator at release.lbs.	......	......
82.	Proportion of feed-water used by cylinders (line 79) accounted for at cut-off........	......	......
83.	Proportion of feed-water used by cylinders accounted for at release........	......	......
84.	Total heat supplied by boiler to cylinders per hour in British thermal units........	......	......
85.	Total heat supplied by boiler to cylinders per minute per indicated horse-power in British thermal units........	......	......
86.	Total heat supplied by boiler to cylinders per minute per dynamometer horse-power in British thermal units	......	......

The following form for the tabulation of the results of locomotive tests will be found convenient. They can, of course, be modified to suit any method of testing, whether standard or not:

LOCOMOTIVE TESTS — GENERAL RESULTS.

................................*Railroad Co.*

...............*Tests of Locomotive No*......, *between*................

and..........................*Distance*......*Miles. Train No*.......,

...............*Bound.* ...., *18*....

Kind of Coal,.......................... *Coal Analysis*.............

Calorimetric Value of Coal,..

Trip No...

Date, ...

Left ....at.....................................

Arrived ....at.....................................

Left ....at.....................................

Arrived ....at.....................................

1. Weather ....
2. Mean temperature of atmosphere..................................
3. Direction of wind..
4. Velocity of wind, miles per hour................................
5. Condition of rails...
6. Weight of train in tons of 2,000 lbs., including locomotive, tender, passengers and freight..
7. Weight of train in tons of 2,000 lbs., excluding the locomotive and tender ....
8. Equivalent number of standard cars at ....tons each.........
9. Size of exhaust nozzle, single or double...........................
10. Maximum boiler pressure by gauge................................
11. Minimum " " " " ....
12. Average " " " " ....
13. Prevailing position of throttle (wide open = 1.00)..................
14. " " " reverse lever (notch) ....
15. " points of cut-off ....
16. Schedule time in motion...
17. Actual " " " ....
18. Time made up in minutes...
19. Aggregate intermediate stops, minutes............................
20. Time during which power was developed, or throttle open..........
21. Maximum number of revolutions per minute.........................
22. Minimum number of seconds per mile...............................
23. Maximum rate of speed, miles per hour............................
24. Average speed, miles per hour....................................
25. Actual weight of coal fired......................................
26. Moisture in coal, percentage.....................................
27. Dry coal fired...
28. Actual weight of wood used.......................................
29. Total weight of coal fired (wood added at .4).....................
30. Weight of refuse in fire-box and ash-pan..........................
31. " unconsumed coal recovered from fire-box and ash-pan.......
32. Total weight of coal consumed (Item 29-31)........................
33. Net weight of ashes in fire-box and ash-pan.......................
34. Weight of cinders (sparks) in smoke-box...........................
35. Percentage of ash in coal...
36. " " cinders (sparks).......................................
37. " " total refuse...

38. Percentage of combustible consumed..............................
39. Weight of combustible utilized....................................
40. Number of miles run per ton (2,000 lbs.) of coal....................
41. " " pounds of coal used per mile...........................
42. Coal used per ton of train per 100 miles............................
43. " " " car mile...
44. Average weight of coal burned per square foot of grate surface per hour ....
45. Total coal per indicated horse-power developed per hour............
46. Average temperature of feed-water..................................
47. Weight of water drawn from tender...........................
48. Waste of injector, leakage, etc..................................
49. Weight of water apparently evaporated (Item 47-48)................
50. Percentage of moisture in steam..................................
51. Water actually evaporated, corrected for quality of steam............
52. Actual evaporation per pound of total coal.........................
53. Equivalent evaporation from and at 212° per pound of coal........
54. " " " " " " " " " combustible.
55. Water used per ton of train per 100 miles..........................
56. " " " car mile...
57. " " " hour while developing power.......................
58. " " " indicated horse-power per hour......................
59. " " " sq. ft. of heating surface, from and at 212°............
60. " " " " " " grate " " " " ....
61. Maximum indicated horse-power developed.........................
62. Average " " " ....
63. Dry steam used per indicated horse-power, per hour, per indicator diagram ....
64. Ayerage number of sq. ft. of heating surface per indicated horse-power
65. Average number of indicated horse-power per sq. ft. of grate surface.
66. Prevailing temperature in smoke-box while using steam.............
67. " draft in smoke-box while using steam, in inches of water.

SHOP TEST.

A. Preparation and Location of Instruments.

In preparing for a shop test the preparations described for the road test should be followed so far as the nature of the test requires. When run as a stationary engine the locomotive is not circumscribed by the conditions of road service, and many provisions required on the road are unnecessary. It is unnecessary to determine the quantity of steam consumed by the air pump and auxiliaries, for these are not brought into use on the shop test; and no occasion exists for finding the quantity lost at the safety valve, for on the continuous shop run the steam pressure can be maintained at a uniform point, and blowing off readily prevented. It is unnecessary to use sacks for the convenient measure of coal, because

the coal can be readily weighed up in lots as fast as needed for the test. It is unnecessary to provide a "pilot-box," and no fixed location of the instruments is required, as on the road test. The feed-water may be weighed before it is supplied to the tank, and the tank may be used in this case as a reservoir, the float showing its depth. The meter would thus be unnecessary as the principal instrument of measurement, but a meter is in all cases useful as a check upon this most important element in the data. The long indicator pipes required on the road test may be dispensed with, and one indicator applied close to each end of the cylinder, a practice much to be preferred to the use of a three-way cock and the single indicator. The dynamometer car is not required, but its equivalent should be provided, consisting of a dynamometer which registers the pull on the drawbar in the same manner as the device used on the road.

The number of assistants required on a shop test is less than that needed for a road test. A good test can be made with four (4) assistants, distributed as follows:

One assistant for operating indicators.

One assistant for measuring water.

Two (2) assistants for general observations and coal measurement.

B. Conditions of Test.

The test should be continued for a run of at least two (2) hours from the time normal conditions have been established.

At the close of the test the water height in the boiler and the height of water in the tank should be the same as at the beginning, or proper corrections made for any differences which may exist.

The fire-box and ash-pit are then cleaned, and such unburnt coal as may be contained in the refuse is separated, weighed and deducted from the total weight of coal fired. The balance of the refuse is weighed, as also the cinders removed from the smoke-box.

During the progress of the test samples of the various charges of coal should be obtained, and at its close a final sample of these should be selected, dried and subjected to chemical analysis and calorimeter test. The weight of the sample as taken before and after drying to ascertain the weight of moisture contained in the fuel.

C. The Data and Results.

The data and results of the shop test can best be arranged in the manner indicated in Table No. 2. So far as these are in common with the data and results obtained on the road test, the forms used on both kinds of test are identical.

TABLE No. 2.

Data and Results of Shop Test on....Engine, made......189......

General dimensions, etc. (to be accompanied by a complete description, with drawings and full dimensions).

1.	Kind of engine..	
2.	Size and clearance of cylinders........................	
3.	Area of heating surface................................	
4.	Area of grate surface..................................	
5.	Diameter of exhaust nozzles............................	
	Total Quantities.	Whole Run.
6.	Duration ....hrs.	......
7.	Weight of dry coal burned, including .4 weight of wood.lbs.	......
8.	Weight of water evaporated corrected for moisture in the steam ....lbs.	......
9.	Weight of ashes and refuse from ash-pan.............lbs.	......
10.	Weight of cinders from smoke-box.................lbs.	......
11.	Percentage of ash as found by calorimeter test....per cent	......
12.	Total heat of combustion per lb. coal as found by calorimeter test............................B. T. U.	......
	Power Data.	
13.	Mean effective pressure, high-pressure cylinders......lbs.	......
14.	Mean effective pressure, low-pressure cylinders........lbs.	......
15.	Average revolutions per minute....................rev.	......
16.	Indicated horse-power, high-pressure cylinders.....H. P.	......
17.	Indicated horse-power, low-pressure cylinders.......H. P.	......
18.	Indicated horse-power, total.......................H. P.	......
19.	Pull on drawbar ....lbs.	......
20.	Dynamometer horse-power ....H. P.	......
	Averages of Observations.	
21.	Average boiler pressure............................lbs.	......
22.	Average steam-chest pressure.......................lbs.	......
23.	Average temperature of smoke-box...................°	......
24.	Average draught suction...........................″	......
25.	Average temperature of feed-water ....°	......
26.	Average temperature of atmosphere...................°	......
27.	Average percentage of moisture in the steam....per cent	......
28.	Maximum percentage of moisture in the steam...per cent	......
	Hourly Quantities.	
29.	Weight of dry coal burned per hour................lbs.	......
30.	Weight of dry coal burned per hour per square foot of grate surface...............................lbs.	......

		Whole Run.
31.	Weight of coal burned per hour per square foot of heating surface....lbs.	......
32.	Weight of water evaporated per hour....lbs.	......
33.	Equivalent weight of water evaporated per hour with feed-water at 100° and pressure at 70 lbs....lbs.	......
34.	Equivalent weight of water from 100° at 70 lbs. evaporated per square foot of heating surface....lbs.	......

Principal Results, Complete Engine and Boiler.

35.	Coal consumed per I. H. P. per hour....lbs.	......
36.	Coal consumed per dynamometer horse-power per hour....lbs.	......
37.	Weight of "standard coal" consumed per I. H. P. per hour....lbs.	......
38.	Weight of "standard coal" consumed for a dynamometer horse-power per hour....lbs.	......

Boiler Results.

39.	Water evaporated per pound of coal....lbs.	......
40.	Equivalent evaporation per pound of coal from and at 212°....lbs.	......
41.	Equivalent evaporation per pound of combustible from and at 212°....lbs.	......
42.	Heat imparted to each pound of steam used from average temperature of feed at average steam pressure in British thermal units....	......

Cylinder Data.

43.	Mean initial pressure above atmosphere....lbs.		......
		H. P. Cyl.	L. P. Cyl.
44.	Cut-off pressure above zero....lbs.	......	......
45.	Release pressure above zero....lbs.	......	......
46.	Compression pressure above zero....lbs.	......	......
47.	Lowest back pressure above or below atmosphere....lbs.	......	......
48.	Proportion of forward stroke completed at cut-off	......	......
49.	Proportion of forward stroke completed at release	......	......
50.	Proportion of return stroke uncompleted at compression....	......	......

Cylinder Results.

51. Total water consumed per indicated horse-power per hour corrected for moisture in steam....lbs.

52. Water consumed per I. H. P. per hour by cylinders alone (from line 51 less all measured losses)....lbs.

Description of Boiler Lever Indicator. Fig. 4.

This apparatus consists of a spirit level mounted in a saddle which slides on an arc of a large circle. This arc is graduated, and should be sufficiently curved to operate on the heaviest grade upon which the engine will be tested.

By putting the engine on jacks or cranes, and giving different elevations to the boiler, the height of water may be measured by means of a meter to certain points on the gauge-glass, and a corresponding table made, which will denote the quantity of water in the boiler for each different angular position of the boiler. These figures can be used to make corrections on the meter readings, allowing for inclinations of the track on which the engine is standing by simply pushing the spirit lever to a horizontal position and noting the reading on the indicator.

SPECIFICATIONS AND TESTS FOR IRON LOCOMOTIVE BOILER TUBES, EXTRA QUALITY.

At the convention of 1895 the following Specifications and Tests for Iron Locomotive Boiler Tubes were adopted as standard (see page 127, report 1895); modified in 1896 (see pages 332, 333, report 1896).

Material.

Tubes to be made of knobbled hammered charcoal iron and lap-welded.

Dimensions and Weights.

Tubes 2 inches, outside diameter.

.095	inch	thick	and	weight	at least	1.91	lbs.	per	foot.
.110	"	"	"	"		2.19	"		"
.125	"	"	"	"		2.47	"		"
.135	"	"	"	"		2.65	"		"

Tubes 2¼ inches, outside diameter.

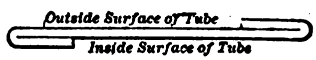
.095	inch	thick	and	weight	at least	2.16	lbs.	per	foot.
.110	"	"	"	"		2.48	"		"
.125	"	"	"	"		2.80	"		"
.135	"	"	"	"		3.01	"		"

Surface Inspection.

Tubes must have a smooth surface, free from all laminations, cracks, blisters, pits and imperfect welds. They must also be free from bends, kinks and buckles — signs of unequal contraction in cooling or injury in manipulation — and must be of uniform thickness throughout, except at weld, where .015 inch additional will be allowed, perfectly round and cut to exact length ordered.

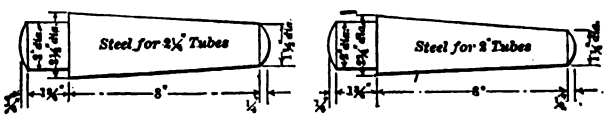
Physical Tests.

1. Strips one-half inch in width by six inches in length, planed lengthwise from tubes, after being heated to a cherry red and dipped in water at 80 degrees Fahrenheit, shall bend in opposite directions at each end as shown in sketch below, without showing cracks or flaws; and when nicked and broken these must show a fracture wholly fibrous, or a test in a testing machine may be substituted for this.



2. Sections of tubes 12 inches long — five inches of which shall be heated to *a bright cherry red in daylight* — when placed in a vertical position, and a smooth-turned tapered steel pin at a *blue heat* is driven in, by "lap" blows with a 10-pound sledge hammer, must stretch to one and one-eighth times their original diameter without split or crack. One tube to be tested, as required in paragraphs 1 and 2, in each lot of 250 tubes or less.

The sketches below show dimensions of steel pins to be used for 2-inch and 2¼-inch O. D. tubes.



3. Tubes must expand, turn over tube plate and bend down without flaw, crack or opening at weld.

Hydraulic Test.

Each tube must be subjected, by the manufacturer, to an internal pressure of 500 pounds to the square inch.

Etching Tests.

In case of doubt as to the quality of material, the following tests shall be used, namely:

A section of tube turned or ground to a perfectly true surface, polished with fine emery paper, and free from dirt and grease, to be suspended in a bath of

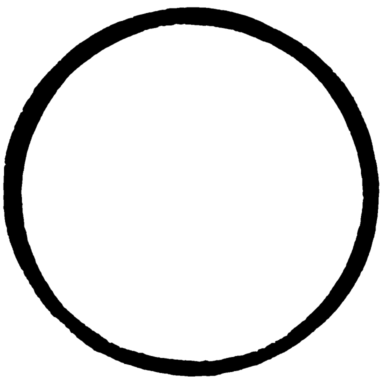
Water	9 parts
Sulphuric acid	3 parts
Muriatic acid	1 part

The bath should be prepared by placing the water in a porcelain dish, adding the sulphuric acid and then the muriatic acid. Chemical action is

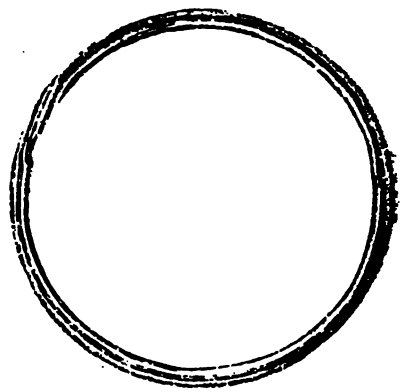
allowed to continue until the soft parts are sufficiently dissolved so that an iron tube will show a more or less finely ridged surface, with the weld very distinct.

General Requirements.

Each tube must be plainly stenciled "Knobbled Hammered Charcoal Iron" and "Tested to 500 Pounds," and tubes must be so invoiced. Each



Steel.



Charcoal Iron.

tube must also be subjected to careful surface inspection, as provided for above; and those measuring one sixty-fourth of an inch over or under the diameter ordered shall be rejected.

DECIMAL GAUGE.

At the convention of 1895 the following was adopted as a standard Decimal Gauge:

1st. The micrometer caliper should be used for laboratory and tool-room work, and in the shop when specially desired.

2d. The solid notch gauge should be used for general shop purposes.

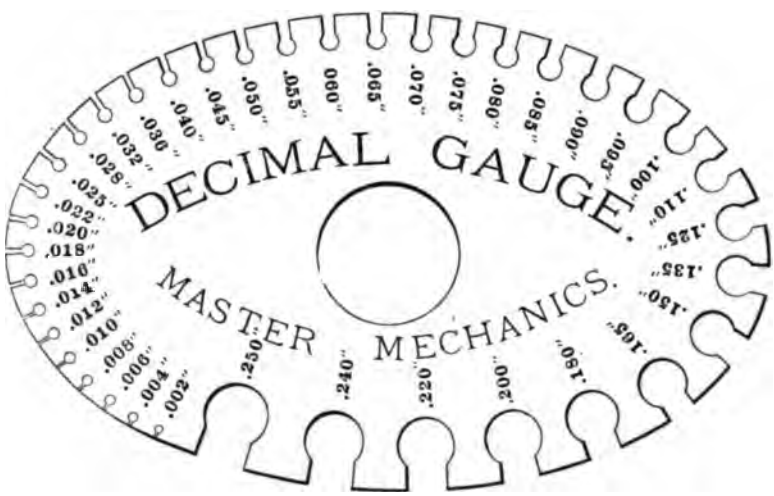
3d. The form of this gauge shall be an ellipse whose major axis is 4 inches, the minor axis 2.5 inches, and the thickness .1 inch, with a central hole .75 inch in diameter.

4th. The notches in this gauge shall be as follows:

.002″	.022″	.060″	.110″
.004″	.025″	.065″	.125″
.006″	.028″	.070″	.135″
.008″	.032″	.075″	.150″
.010″	.036″	.080″	.165″
.012″	.040″	.085″	.180″
.014″	.045″	.090″	.200″
.016″	.050″	.095″	.220″
.018″	.055″	.100″	.240″
.020″	.....	.....	.250″

5th. All notches to be marked as in the above list.

6th. The gauge must be plainly stamped with the words "Decimal Gauge" in capital letters .2 inch high, and below this the words "Master Mechanics."



7th. In ordering material, the term gauge shall *not* be used, but the thickness ordered by writing the decimal as in above list. For sizes over ¼ inch, the ordinary common fractions may be used.

BRIGGS STANDARD WROUGHT-IRON PIPE THREADS.

At the convention of 1899, what is known as the Briggs Standard, as determined by the Pratt & Whitney gauges, of threads for wrought-iron pipe and couplings, was adopted as a standard of the Association.

The gauges used by the Pratt & Whitney Company were made by them from an autograph copy of a table made by Mr. Robert Briggs per-

sonally, who originally established and published these standard threads. A copy of it is as follows:

STANDARD DIMENSIONS OF WROUGHT-IRON WELDED TUBES. BRIGGS STANDARD.

Diameter of Tube.			Thickness of metal.	Screwed Ends.	
Nominal inside.	Actual inside.	Actual outside.		Number of threads per inch.	Length of perfect screw.
Inches.	Inches.	Inches.	Inch.	No.	Inch.
1/8	0.270	0.405	0.068	27	0.19
1/4	0.364	0.540	0.088	18	0.29
3/8	0.494	0.675	0.091	18	0.30
1/2	0.623	0.840	0.109	14	0.39
3/4	0.824	1.050	0.113	14	0.40
1	1.048	1.315	0.134	11½	0.51
1¼	1.380	1.660	0.140	11½	0.54
1½	1.610	1.900	0.145	11½	0.55
2	2.067	2.375	0.154	11½	0.58
2½	2.468	2.875	0.204	8	0.89
3	3.067	3.500	0.217	8	0.95
3½	3.548	4.000	0.226	8	1.00
4	4.026	4.500	0.237	8	1.05
4½	4.508	5.000	0.246	8	1.10
5	5.045	5.563	0.259	8	1.16
6	6.065	6.625	0.280	8	1.26
7	7.023	7.625	0.301	8	1.36
8	7.982	8.625	0.322	8	1.46
9	9.000	9.688	0.344	8	1.57
10	10.019	10.750	0.366	8	1.68

Tapers of conical tube ends, 1 in 32 to axis of tube. (¾-inch per foot.)

By the late action of the Manufacturers of Wrought-Iron Pipe, 9-inch outside diameter has been excepted from the original list, as above noted, the diameter now adopted being 9.625 instead of 9.688 inches given in the Briggs table.

SQUARE BOLT HEADS.

In 1899 the following dimensions for square bolt heads were adopted as standard:

The short diameter of head shall be one and one-half times the diameter of the bolt, and the thickness of head shall be one-half the short diameter of the head.

Specifications for Cast-iron Wheels.

1. The chills in which the wheels of any one wheel maker are cast shall be of equal diameters, and the same chill must not vary at different points more than one-sixteenth of an inch in diameter.

2. There shall not be a variation of more than one-half inch in the circumference of any given number of wheels of the same nominal diameter, furnished by any one maker, and the same wheel must not vary more than one-sixteenth of an inch in diameter. The body of the wheel must be smooth and free from slag or blow holes. The tread must be free from deep and irregular wrinkles, slag, chill cracks and sweat or beads in the throat which are one-eighth of an inch or over in diameter, or which occur in clusters of more than six inches in length.

3. The wheels broken must show clean, gray iron in the plates; the depth of pure white iron must not exceed seven-eighths of an inch or be less than three-eighths of an inch in middle of the tread, and shall not be less than three-sixteenths of an inch in the throat. The depth of the white iron shall not vary more than one-fourth of an inch around the tread on the rail line in the same wheel.

4. Wheels shall not vary from the specified weight more than two per cent.

5. The flange shall not vary in the same wheel more than three thirty-seconds of an inch from its mean thickness.

6. The single plate part of a 33-inch wheel, known as the Washburn pattern, shall not be less than five-eighths of an inch in thickness in a wheel weighing from 550 to 575 pounds, and not less than three-fourths of an inch in thickness in a wheel weighing from 575 to 600 pounds.

Tests for Cast-iron Wheels.

1. For each hundred wheels which pass inspection and are ready for shipment, one representative wheel shall be taken at random and subjected to the following test:

The wheel shall be placed flange downward on an anvil block weighing seventeen hundred (1,700) pounds, set on rubble masonry at least two feet deep, and having three supports not more than five inches wide for the wheel to rest upon. It shall be struck centrally on the hub by a weight of one hundred and forty (140) pounds, falling from a height of twelve (12) feet. Should this wheel stand five (5) blows without breaking into two or more pieces, the hundred wheels shall be accepted. Or, wheels must be of such strength that 550 to 575 pound wheels shall require twenty (20) blows, and 575 to 600 pound wheels shall require thirty (30) blows of a hundred (100) pound drop falling seven feet on the plate close to the rim to break a piece out — the wheel resting upon a cast-iron plate weighing not less than one thousand (1,000) pounds.

2. Should in either case the test wheel break into two or more pieces with less than the required number of blows, then a second wheel shall be

taken from the same lot and similarly tested. If the second wheel stands the test, it shall be optional with the inspector whether he shall test a third wheel or not. If he does not so elect, or if he does and the third wheel stands the test, the hundred wheels shall be accepted.

3. The above tests shall apply to standard weight wheels from 26 inches to 42 inches diameter, used on standard gauge roads.

Form of Contract.

THIS INDENTURE, made this......day of......18.., between.......... party of the first part, and..........party of the second part, WITNESSETH:

1. The party of the first part hereby agrees to furnish to the party of the second part, free on board cars at......chilled cast-iron wheels, ... inches in diameter under the following conditions.

2. The party of the second part hereby agrees to pay to the party of the first part......dollars for each wheel furnished, and to keep an accurate record of the mileage made by the wheels placed in service under cars in passenger equipment and under locomotives and tenders, and an accurate record of the number of months of service of the wheels placed under cars in freight equipment.

3. The party of the second part hereby agrees when any wheel furnished under this contract is scrapped, to furnish to the party of the first part a statement which will show

1.—The wheel number.

2.—The service in which the wheel ran.

3.—The amount of service in months or miles.

4.—The cause of failure.

5.—A charge against the party of the first part of fifty-five per cent (55 per cent) of the price of the wheel mentioned above.

6.—A credit to the party of the first part of

....	cents	per 1,000	miles for	36	in.	passenger	equipment
....	"	"	"	33	"	"	"
....	"	"	"	30	"	"	"
....	"	"	"	36	in.	locomotives and	tenders
....	"	"	"	33	"	"	"
....	"	"	"	30	"	"	"
....	"	"	"	28	"	"	"
....	"	"	"	26	"	"	"
....	"	per month	for	36	in.	freight	equipment
....	"	"	"	33	"	"	"
....	"	"	"	30	"	"	"

except in the case of wheels made flat by sliding, or removal for sharp flanges or other unfair treatment, which have not made sufficient service to balance the charge against the party of the first part as above; in such case a service credit shall be made which shall balance the charge.

4. The party of the first part hereby agrees that on presentation of the statement to pay to the party of the second part any balance due from lack of sufficient service on the part of the wheels (with above exceptions) to balance the charge; and the party of the second part hereby agrees to pay to the party of the first part any balance due as shown by the aforesaid statement — settlements to be made quarterly. It is, however, understood and agreed that no credit shall be allowed for excessive mileage for time service on freight wheels beyond the time guaranteed.

5. The party of the second part hereby agrees to hold subject to the inspection of the party of the first part, for a period of thirty days after the said statement has been rendered, any wheels (with above exceptions) which have not earned for themselves a credit equal to the amount charged against them.

Service Guarantee.

36 inch passenger wheels	70,000 miles
33 " " "	60,000 "
36 inch engine and tender wheels	60,000 "
33 " " "	50,000 "
30 " " "	45,000 "
26 and 28 inch engine and tender wheels	40,000 "
Refrigerator, through line and cattle cars	24 months
All other freight cars	48 "

Settlements of claims for non-performance of guaranteed service shall be made upon the basis of mileage and time guarantee as above.

AIR-BRAKE AND SIGNAL INSTRUCTIONS.

At the convention of 1892 a code of Air-brake and Signal Instructions was adopted as Recommendation of the Association. Some modifications were made in 1898, and the modified rules are shown on pages 205-228, report 1898.

CODE OF APPRENTICESHIP RULES.

At the convention of 1898 the following code of rules was adopted as the Recommendation of the Association:

Code of Apprenticeship Rules.

1. A regular apprentice is one who has had no previous shop experience and is not a graduate of a technical institution.

2. No regular apprentice shall be taken into the shop below the age of fifteen or after the age of nineteen years.

3. No apprentice shall be taken into the shop who has not received the elements of a common education, and who does not give evidence of such capacity as to promise the ability to become a competent mechanic.

4. No apprentice shall be taken into the shop without the consent of his parents or lawful guardians, who shall have a thorough understanding

.e conditions of such apprenticeship, and who shall execute such docu-:s, including a release of the company from liability for accidents to aid apprentice, as the company may require.

;. The term during which an apprentice shall serve before receiving ·tificate of apprenticeship shall not be less than three years, nor more five years.

5. There shall be a regular apprentice course framed for each shop, h course each apprentice shall go through during his term, the time : spent on each class of work being defined, and such definition shall ɔserved as closely as practicable with due regard to the capacities and ition of the individual apprentice.

7. During the term of the apprenticeship a careful and proper record be kept of the work and progress of the apprentice, and also of the ral behavior and conduct, which record shall be entered on properly ɔrized blanks or books provided for the purpose not less frequently once every week during such term.

3. Each apprentice shall be paid for the work done by him upon a duly agreed on and provided for in advance.

). Under no circumstances shall the company assume any liability he employment of an apprentice after the conclusion of his term.

:o. On the conclusion of the term of apprenticeship, each apprentice be given a certificate in a proper form, duly signed by the proper :r of the company, which shall set forth the length of time which each ɜntice has served and the work on which he has been engaged, as well ıme indication of his general behavior during his term.

:1. Apprentices who have already served part of a term in other ;, or who have taken part of a course at a recognized technical institu-may be received under such modifications of the foregoing rules as be deemed proper.

mmendations Supplementary to the Code of Apprenticeship Rules.

ꝶULE 3. An apprentice should be able to read and write, and have a ·ledge of arithmetic. Some companies insist that a candidate shall reached a point in his studies equivalent to that of the eighth grade ɜ public schools. This standard, where applicable, will be found sat-ɔry.

ULE 4. The following is a blank form of release which is recom-·d as satisfactory:

APPENDIX "C."

(Form for Release of Minors.)

HEREAS, The A. B. C. Railroad Company has agreed to take into its

....

r, subject to discharge at the pleasure of the company, and has with our consent to pay him the compensation to be earned for his

services, and has been authorized to take from him such receipts and acquittances as the said company may require;

AND WHEREAS, The said ....
by reason of such employment, will be subjected to great risk of personal injury from neglect of other employes, agents and officers of the said company, and from defects of machinery, and from other causes;

AND WHEREAS, In the event of injuries to the said..................
......................................, whether resulting fatally or otherwise, the said...
or members of his family might make claims for damages against the said company;

NOW, IN ORDER to release the said company from all claims or liability for damages for injuries of any and all kinds, from any cause whatsoever, ...the father, and
....the mother, in their several and individual capacities, and acting as guardian for the said
...., and the said
....himself, in consideration of the employment by the said railroad company of the said
....in the service of the said company, and in consideration of the sum of one dollar now in hand paid by the said company, do hereby release and forever discharge the A. B. C. Railroad Company for all claims for damages, and do also further agree to release the said company from all claims and liability for damages arising out of any injury or injuries to the said.....................
....resulting from the character of his employment, from the negligence of other employes, or agents or officers of the said company, from defects of machinery or any other cause or causes whatsoever, whilst a minor and whilst in the service of the said company in any capacity whatsoever.

WITNESS our hands and seals this...............day of......18....

............................[SEAL]

WITNESSES: ....[SEAL]

....[SEAL]

....[SEAL]

....[SEAL]

RULE 5. Four (4) years is recommended as the best standard term. Whenever possible this should be adopted. The limits given in the rule, "not less than three nor more than five years," are made sufficiently wide to cover all special cases. The brightest and most ambitious boy should not be permitted to complete his course in less than three years under any circumstances. A boy who does not complete it in five years had better be something else than a mechanic.

RULE 6. The following courses are recommended for the various shops:

Machine Shop.

Tool Room.— General use of tools, names, etc., work on small planer, drilling machine, shaper and lathes, provide tools; six months to actually serve.

Erecting Shop.— Helping on general work — gang No. 1, one month; helping on general work — gang No. 2, one month; helping on general work — gang No. 3, one month.

Machine Shop.— General instructions, milling machine, boring mill, horizontal machine, axle lathe, and helping in general; three months to actually serve.

Boring, driving and truck brasses and quartering machine; two months.

Cylinder boring machine and planer; one month.

Rod: Rod gang, three months; small lathe (alone), two months; large slotter, one month; brass lathe, two months; small planer, one month; large and small planers, two months; driving wheel lathe, one month; large lathe (alone), two months; motion work lathe, one month; general vise work, three months; surface table, three months.

Erecting Shop.— General work — gang No. 1, five months; general work — gang No. 2, three months; general work — gang No. 3, four months.

Total number of months' actual service — forty-eight.

Your committee submits this as a basis for an adequate course of training in the machine shop, with the distinct understanding that it is to be qualified so far as the term of service to be spent in the different items, and also in the whole course, by the quality and capacity of the individual boys, under the discretion of whoever has them in charge.

Blacksmith Shop Course.

1. To start the apprentice on a bolt machine for six months. Here he will learn the rudiments of heating iron; also the setting and adjusting of dies, and at the same time by observation will learn the names of the tools and their use in that portion of the shop.

2. The next six months in operating a steam hammer. In this position he has a good opportunity to note how the blacksmiths handle and form iron; at the same time require him to help at the fires in the immediate vicinity of the hammer.

3. The next six months should be as a helper on a small fire, with a man who is quick and handy with light work.

4. The next six months on a light fire without a helper, where he will learn to handle the hand hammer.

5. For the next three months give him a light fire with a helper; the fire should be so located that he will be called upon to assist in taking heats for the larger fires.

6. For the next six months on heavier work that does not require skill.

7. For the next three months put him helping at the tool-dressing fire, and if the shop has two tool-dressing fires, the next three months on the second tool-dressing fire.

8. The next twelve months put him on a heavy fire with as much of a variety of work as can be arranged.

Boiler Shop Course.

1. The first three months heating light rivets.
2. The next three months helping on the heavy sheet-iron work, such as wheel covers, ash pans, etc.
3. Three months holding on rivets for tank work.
4. Three months holding on rivets for boiler work.
5. Six months riveting on patches, chipping and calking on tank work.
6. Six months setting flues.
7. Six months patching and bracing boilers, chipping and calking and general riveting.
8. Six months blacksmithing, to learn how to make and fit braces, to dress necessary tools and assist in fitting up his work.
9. The fourth year to lay out flange and do general boiler work.

RULE 7. It is recommended that some one person be given direct charge of all apprentices and be held responsible for their proper instruction. He can be known as "the Foreman of Apprentices," or he can be designated to perform the duties, without special title, in conjunction with his ordinary work. The following blank page for an Apprentice Record Book is recommended:

APPRENTICE RECORD.

NAME.	WEEKS.																			TOTAL WEEKS WORKED.	AVERAGE CREDIT. CONDUCT AND ABILITY.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14 up to 52 weeks.							
John Doe	80	50	90	70	50	30	90	80	70	50	30	90	80	70	40	70	80	50	30	....	63
James Smith	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	....	....
Chas. Jones	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	....	....

RULE 8. The scale of pay must be governed largely by geographical and individual conditions. It is recommended that the rate of pay be 50 cents for a ten-hour day for the first year, with an increase of 25 cents a day for each year thereafter. For an eight-hour day 40 cents a day at the start and 20 cents a day increase yearly.

RULE 9. The following form of certificate is recommended:

APPENDIX "B."

(Form of Certificate of Apprenticeship.)

A. B. C. RAILROAD COMPANY,

MOTIVE POWER DEPARTMENT.

CERTIFICATE OF APPRENTICESHIP.

....
has served an apprenticeship as....................................
at the shops of this Company at....................................
during the period from........................to......................
and has made................hours' time over 10 hours per day.

WORK ON WHICH EMPLOYED.

APPROXIMATE NO. OF MONTHS.	KIND OF WORK.
....	....
....	....
....	....

OFFICERS UNDER WHOM EMPLOYED.

NAME.	TITLE.
....	....
....	....
....	....

GENERAL RECORD OF APPRENTICE.

....
....

Supt. Motive Power.

RESOLUTIONS.

At the convention of 1873 the following resolutions prevailed:

Resolved, That it is the sense of this Association that all trucks under all engines, tenders and cars should be provided with safety chains. (See pages 83-96, report 1873.)

Resolved, That in the opinion of this Association no practical advantage will result from the use of loose wheels or compound axles in ordinary railway service. (See page 143, report 1873.)

At the convention of 1885 the following resolution prevailed:

Resolved, That it is the sense of this convention that steel is the proper material for fire-boxes. (See page 67, report 1885.)

At the convention of 1886 the following resolutions prevailed:

Resolved, That this Association deprecates the giving of testimonials or recommendatory letters for publication, and enjoins all to restrict matters of this nature to letters of inquiry. (See page 26, report 1886.)

Resolved, That it is the sense of this convention that in practice it is unnecessary to bead flues in the front end. (See page 152, report 1886.)

At the convention of 1888 the following resolutions prevailed:

Resolved, That it is the sense of this convention that a brick arch applied to the fire-box of the locomotive is a desirable addition for all service and a positive advantage. (See page 74, report 1888.)

Resolved, That it is the sense of the Master Mechanics' Association that the pilots of all engines should have steps placed on the front end for the safety and convenience of brakemen while coupling at the front ends. (See page 162, report 1888.)

At the convention of 1893 the following resolution prevailed:

Resolved, That while the Master Mechanics' Association regards the water glass as a convenience and an additional precaution against low water, we do not regard it as an absolute necessity to the safe running of locomotives. (See page 161, report 1893.)

At the convention of 1896 the following resolutions prevailed:

Resolved, That it is the sense of this meeting that the radial stay boiler is as safe as the crown bar boiler, and that the former is easier to keep clean and more economical in repairs. (See page 280, report 1896.)

Resolved, That it is the sense of this Association that the statement of the performance of locomotives should be made on the basis of train load, in lieu of train miles or loaded car miles, as is the prevailing practice at present. (See page 333, report 1896.)

At the convention of 1899 the following resolutions prevailed:

Resolved, That it is the sense of this convention that the time has not arrived when we can abandon instructions to those who use the air-brakes, but that the time has arrived when we should perhaps take more care to instruct those who repair the brakes and keep them in order. (See page 71, report 1899.)

Resolved, That it is the sense of the American Railway Master Mechanics' Association that the use of fusible plugs in the crown sheets of locomotive fire-boxes is not conducive to the prevention of the overheating of the crown sheet. (See page 153, 1899 report.)

Resolved, That it is the sense of this Association that the ton-mile basis for motive power statistics is the most practical, and encourages economical methods of operating; and that it is desirable that the heads of motive power departments urge its adoption on their managements. (See page 173, report 1899.)

Resolved, That it is the sense of this Association that it is not advisable to use bars in exhaust nozzles. (See page 277, report 1899.)

At the convention of 1901 the following resolutions prevailed:

Resolved, That it is the sense of this Association that a strict comparison of motive power statistics, one road with another, will not secure the best results, but that such comparisons should be made with the records of the same division for preceding periods of time. (See page 79, report 1901.) (See modification, page 70, 1902 report.)

Resolved, That it is the sense of this Association that the ton-mileage of the locomotive is a just credit to the motive power department for statistical purposes. (See page 83, report 1901.) (See modification, page 77, 1902 report.)

Resolved, That it is the sense of this Association that it is necessary that the side rods should be on engines traveling from the works to the railroad they are built for. (See page 99, report 1901.)

At the convention of 1902 the following resolutions prevailed:

"*Resolved,* That it is the sense of this Association that conclusions based on a comparison of the statistics of one railroad with another may easily prove incorrect, should be given less weight than they usually are, are just only when the accompanying conditions are fairly well known and their influence can be determined with some degree of accuracy; that a comparison of the statistics of a division or a system with those of the same territory for a previous corresponding period very largely eliminates

these uncertainties and makes conclusions based on such a comparison much more reliable."

"*Resolved,* That it is the sense of this Association that the ton-mileage of the locomotive and caboose is a just credit to the motive power department for statistical purposes."

"*Resolved,* That the ton-mile is the best practical basis now available for motive power and operating statistics by which to judge the efficiency of locomotive and train service.

"*Resolved,* That actual tonnage should be used in computing ton-mile statistics for comparison with those of other roads, but for comparison with the previous records of the same system or division the use of adjusted tonnage is advisable.

"*Resolved,* That the statistics of passenger, freight, work train and switching services should be on the ton-mile basis, each service in a separate group, and passenger and freight service to be each further grouped under Through and Local.

"*Resolved,* That the statistics of branch lines and main lines should be kept separately.

"*Resolved,* That the credit of ton-mileage for locomotives in switching service should be proportional to their tractive power.

"*Resolved,* That the ton-mileage of trains using more than one locomotive should be divided among the locomotives attached to these trains in proportion to their tractive power and for the distance over which the helping locomotives are used.

"*Resolved,* That the tonnage of the locomotive should be its weight in working order, plus the light weight of the tender and half its capacity of coal and water."

Obituary.

W. A. FOSTER.

Mr. Foster was born at Brattleboro, Vermont, February 10, 1835. He was educated in the high school at Brattleboro. At the age of sixteen he began working for the Vermont & Massachusetts Railroad, at Brattleboro, as engine wiper in the roundhouse. In October, 1852, he began firing, since which time he has been, in 1857 to 1861, machinist in the repair shop; 1861 to 1864 foreman in the repair shop; 1864 to 1873 locomotive engineer; 1873 to 1885 Assistant Superintendent Motive Power, Fitchburg Railroad (the Vermont & Massachusetts Railroad being bought by the Fitchburg Railroad).

He came to Corning in June, 1885, and became Superintendent of Motive Power and Rolling Stock for the Fall Brook Coal Company, later called the Fall Brook Railway, which position he held until the New York Central & Hudson River Railroad took the Fall Brook Railway, working for the Central up to his death. During his life he perfected many inventions which were of much value in mechanical engineering. While he was Assistant Superintendent of Motive Power at Fitchburg he invented a locomotive valve gear, which has given excellent service.

While living in Fitchburg he was alderman for the first ward of that city. Also, when Corning was incorporated as a city he was elected Supervisor in the first and second wards of the new city.

Mr. Foster was in feeble health for the last three or four years, suffering from Bright's disease. July 2 Mr. Foster and family went to Greenfield, Massachusetts, expecting to visit friends there and in Vermont, but was taken with a chill, gradually growing worse, and being confined to his bed only a week when, on July 23, he passed away.

He began to lose his eyesight several years ago, and during the last year and a half he could not see to read, and scarcely to get around, notwithstanding which he was always happy and cheerful, and very patient, never complaining. He was always ready to help the poor and needy, using his influence to have men lead higher and purer lives. He was married October 22, 1884, at Greenfield, Massachusetts, to Annie Murray Smith.

Mr. Foster was a member of the American Society of Mechanical Engineers. He became a member of the American Railway Master

Mechanics' Association in 1875. and at the time of his death was an honorary member of it.

He leaves a widow, two daughters and one son to mourn his loss.

E. A. WALTON.

ANGUS BROWN.

Angus Brown, Division Superintendent of Motive Power of the New York Central at West Albany, was instantly killed by a train, January 21,

1902, as he was going from his office to his home at noon. This shocking accident removes one of the most promising of the staff of the New York Central. He had been at West Albany less than a year, and in that time

had won a position with superiors and subordinates which is given to but few men to attain, and the grief of all who knew him, especially those in immediate contact with him at Albany, is expressive of the highest honor and esteem, and marked the influence of his quiet, unassuming, self-forgetful life. The writer was privileged to know him, and the sad duty of giving the news to his friends carried with it a melancholy pleasure in pointing to his high character, honesty of purpose, quiet and forceful way, which made him a power among men, and brought him absolute trust and high regard from his officers. To these attributes were added an unusual ability and breadth of view. Such men are needed everywhere, and especially in charge of large bodies of men, where example is so important, and where management is becoming increasingly difficult.

He had a fine record of seventeen years on the Northern Pacific, and was afterward Superintendent of Motive Power of the Wisconsin Central.

As he was laid away one of the shopmen said, with tears, that he had never had such a Superintendent.

[COMPLIMENTARY NOTICE FROM "AMERICAN ENGINEER."]

ANGUS BROWN.

Were a star quenched on high,
For ages would its light
Stream downward from the sky
Upon our mortal sight,
So, when a good man dies,
For years beyond our ken,
The light he leaves behind him lies
Upon the paths of men.

In the prime of life, and with encouraging prospects for a brilliant future, Angus Brown was, in an instant, removed from the surroundings of an active life, and carried over the "great divide" into the boundless realms of eternity. At noon on January 21 of the current year he was instantly killed by an incoming train, which came upon him unnoticed, and while absorbed in thought.

Mr. Brown, at the time of his death, occupied the position of Division Superintendent of Motive Power of the New York Central & Hudson River Railroad, with headquarters at West Albany, New York. By birth a Canadian, descendant of Scotch parents, he inherited the many estimable qualities which made him a man among men. With the benefit of only a public school education, he embarked upon the world at an early age, and entered upon an apprenticeship to the machinist trade with the John Abell Engine Works, at Woodbridge, Ontario. After five years of faithful service, with acquired knowledge and a recognized ability as a mechanic, he broadened his experience and added to his store of knowledge by working in different shops, first engaging in railroad work in the Muskegon shops of the Chicago & West Michigan Railroad in 1880. In 1882 he went to Brainerd, Minnesota, and entered the shops of the Northern Pacific at that

place, where his ability as a workman and his qualifications for managing details were soon recognized, and through the successive steps of gang foreman, machine foreman and general foreman, he was promoted to the position of Master Mechanic of the Yellowstone Division at Glendive, Montana, in 1886. In 1890 his jurisdiction was extended to include the Montana Division, with headquarters at Livingston, Montana. In this capacity he remained until the year 1898, when he resigned to accept the position of Superintendent of Motive Power and Cars of the Wisconsin Central Railroad, with headquarters at Waukesha, Wisconsin. Terminating his services with the latter road in 1900, he assumed charge of the mechanical department of the Chicago Terminal Transfer Railroad for a few months, resigning to accept the position he held at the time of his death.

Mr. Brown was a man of strong individuality and of an attractive personality. Imbued with a firm conviction as to "what is right as we are given to understand it," his life was one of unswerving rectitude, and both in public and private was above reproach. Possessed of a natural faculty for enlisting the good will and winning the admiration and respect of all with whom he came in contact, he presented the highest type of humanity, and was an honor to mankind. Endowed with an indomitable will, never lacking in perseverance, having always the courage of his convictions, the record of his life is one of earnest and honorable effort in the duties to which he was called. In the several offices he occupied his name is treasured in kind remembrance by all, and the cheery smile, the friendly greeting, the kind reproof and the manly man will never be forgotten.

> "Generous as brave,—
> Affection, kindness,— the sweet offices
> Of love and duty — were to him as needful
> As his daily bread."

Mr. Brown had been a widower for a number of years, and lived with his mother and sister. In social life he wore the stamp of a true man, devoid of ostentation, broadminded, charitable and upright. Devoted to home and its surroundings, with a strong attachment for family ties, ever greeting with a hearty welcome all friends, his death is a loss too deep for words, but the history of his life will long live as an incentive to other young men who have been encouraged by the example and life of Angus Brown.

AN ADDRESS AT THE FUNERAL OF MR. ANGUS BROWN

By Rev. Geo. N. Karner in the West End Presbyterian Church,
Albany, January 23, 1902.

FELLOWMEN,— In the seventh chapter of Matthew we read the words, "Every good tree bringeth forth good fruit — wherefore by their fruits we shall know them." It is by the fruits of his life that I knew Mr.

Brown, and those fruits lead me to believe that he was a good man; a man who, although with us but a few months, yet in those months ever growing in the friendship of the men, and the estimation of the officials.

In my inquiries I have yet to find a man who was not enthusiastic in his praise of the character and worth of Angus Brown. And one need only to read the memorials of his associates to discover that wherever he has been he left that record.

Angus Brown was born April 3, 1856. In a home where the purest Scotch principles of industry, honesty and integrity were always taught and practiced he was given a foundation upon which he built the sterling character and developed the "honest manly heart" that was admired by all who knew him best. He received a good grammar school education; and wherever he went always gave himself to the hard study of mastering his business.

He served his apprenticeship at Woodbridge, Ontario. Two of his friends who served there with him told me yesterday that at first young Brown was thrown, especially at his boarding-place, among the roughest class of boys and young men, and consequently met with great temptations. But even then his fist would go down, and he would emphatically refuse to drink or gamble. The habits of his early home life were good. It was born into him to be good and manly, and withal courageous, and his influence for temperance and sobriety and clean living can only be imagined. He was, however, as his friends expressed it, as full of mischief as any of us, and many was the frolic in which he took an active part. If some of us were caught in scrapes it was enough to say, "We were with Angus Brown," and it was generally taken for granted that we were, therefore, in pretty good company.

He soon developed into a man of pure purposes, great force of character and a leader of men. Although at times it operated to his apparent disadvantage, he would stand up for the right though faced by an enemy, and never budge from his position.

He was a man that could not be induced to do anything that savored of dishonesty, and would not consider for a moment the taking of a mean advantage of anyone. When, however, at fault, he was ever ready, like a man, to acknowledge it and make amends if possible. This showed his fine sense of courage, for it often takes more courage to acknowledge a fault than to face an enemy. And so this man of great endurance, calm and collected in every emergency, capable of solving many hard problems of railroad life, and withal imbued with that rare accomplishment of knowing how to meet and handle men, was naturally sought for by one road after another. His every move was an advance in duty and responsibility. It seemed to many that some day he would reach the highest round in the ladder of railroad possibilities.

He first attracted attention as Master Mechanic of one of the most important divisions of the Northern Pacific. Next we hear of him as Superintendent of Motive Power and Cars on the Wisconsin Central.

For a few months he gave himself to the work of trying to solve the problem of the network of railroads in the suburbs of Chicago. Then he was called by our New York Central Railroad as Division Superintendent of Motive Power. And just as he seemed to be gathering himself and associates together for a mighty pull for great results, there came in the Mystery of God his untimely death. Thus in a moment a good man, beloved by many, and respected by all, was taken. We bow in humble submission to an all-wise Providence, and say with reverence, "The Lord's will be done."

While at Glendive, Montana, on the Northern Pacific, Mr. Brown married a sweet and estimable woman. But before a year had passed death claimed her, as it now has claimed him. She was buried with her babe, at Brainerd, Minnesota. There his beloved mother and devoted sisters will now accompany his remains, to be interred by the side of his wife and child. His wife's aged mother is still living, and will meet the sorrowing and sad company. May the God of all comfort, help and sustain the afflicted. And may we learn more and more what pure and undefiled religion before God and the Father is, namely: "To visit the fatherless and widows in their affliction, and to keep ourselves unspotted from the world."

But, men, have you asked why this great gathering? Why these handsome floral tokens? Why this remarkable demonstration of regard and respect for a man whom many of you have known but for a few months? Is it to be traced to his success? Is it because of his position or ability? Great as was his success and ability, and high his position among you; yet I think the cause is not there — it is the man. The man who stood foursquare — *physically, mentally, morally and spiritually* — "to every wind that blows."

God blessed Angus Brown with a strong and able body. Physical strength is one of God's good and perfect gifts, and is an adornment and glory to any man.

He was also blessed with sound reason, calm judgment and vigorous brain. He was mentally strong. A great thinker, he was often buried in thought, and in this way, seemingly unconscious of an approaching train, he met his sudden death.

Again, moral strength was his pride and glory. He was a man of purity of habit, purpose and character. With victory over self, he neither smoked, used wine nor strong drink, and no one can be found that ever heard him utter an oath. The testimony of one is: "I have been with him on all sorts of occasions, and I never heard him use language that could not have been used in the presence of his mother and sisters." Have you heard what was almost the first thing Mr. Brown did when he reached his office at West Albany? He took out of his pocket his mother's picture, placed it in a prominent position on his desk, and there it was always — the spirit of his mother and his mother's God inspiring him to keep unspotted from the world — and there it is on his desk to-day, a silent

testimony of his affection and love, and speaking to all clerks in that office not to forget their mother and their God.

Again, Angus Brown was *spiritually* strong. True and undefiled religion with him was to keep himself unspotted from the world, and to do unto others as he would have others do unto him. Fellowship and brotherly love is a part of spirituality, and he loved to meet his fellowmen and fellowship with them. It was his delight to have a good visit and tell of his early experiences and draw out yours. Kindness of heart was another characteristic of his religion. I must tell this story, which may give you some conception of his great, sympathetic heart. One of his men, who had worked with him in the earlier days at the bench, while on the Northern Pacific injured his hand, went home, and while there was taken with the typhoid fever. Sick unto death, he thought he might get well if he could only see Angus Brown. As soon as Brown heard of the request he went fifteen hundred miles, nursed his friend to health, and do you wonder that that man to-day is here to mourn his benefactor?

Again, why did that now famous Happy New Year announcement, posted December the 31st, mean so much to so many of you men? It meant so much because you had learned that Mr. Brown never posted anything or said anything that he did not mean. It meant something because of the man back of it.

Again, generosity was a part of his religion. I could tell you of many he has assisted and helped. Those who have tasted of that generosity know best what was in the heart of this great, charitable-minded man.

After all this testimony I ask myself, is there yet one thing lacking? On that terrible day of the accident, while with the family at the home, I overheard the sister say, "And, oh, what a beautiful prayer he made last night." My heart leaped with joy when I learned in answer to inquiry that it was his custom to read a chapter and lead in prayer every night. That last Monday night of his life he did not come in till after midnight, but his mother and sister were up, and coming down to the library, they knelt in prayer while "brother prayed so earnestly and fervently." Men, your superintendent was a man of prayer, a man of Christian character — a man found in favor with men, and surely found in favor with God. I seem to hear his "well done," because he tried to do well.

Men, what is the basis of your estimate of a man's true worth after all? Is it not *Christian* character? We are here in numbers and with evidences of our appreciation of this man — not so much because of his ability and success as because of his *Christian character.* I call upon you, then, with this evidence before you, to go forth into your life with energy and courage, cultivating every means of grace — seeking the "Way, the Truth and the Life" till you show forth that Christian character that counts for so much in men's judgment and in *God's.*

"Every *good* tree bringeth forth good fruit." May God sanctify to us all this affliction to our growth in grace and the salvation of our souls. Amen.

MR. JOHN H. LEEDS.

The unusual and interesting career of Mr. Leeds terminated by his sudden death by heart failure in the Grand Central Station, New York, September 24, 1901. He was born in Darien, Connecticut, March 4, 1836, and lived to the age of sixty-five years. As a boy he became thoroughly familiar with the trains on the New York & New Haven Railroad, which was then a single-track line, running near his home, and soon had an opportunity to use his knowledge of the operation of the road in an act remarkable in a sixteen-year-old boy. He noticed a train coming in one direction when he knew that a passenger train was due in the opposite direction. He distinguished himself by stopping both trains without a collision, and received acknowledgments from the passengers, and the directors of the road presented him with a life pass, which he carried fifty years. This act brought him an opportunity to enter the service of the road, which he did in 1854, as a machinist apprentice, at New Haven. Five years later he ran an engine on what is now a division of the New York, New Haven & Hartford Railroad, then known as the New Haven & North Hampton Railroad, or more generally referred to as the "canal," because it was built on an old tow-path. Early in 1860 he was called to the superintendency of the baryter mill of the Stamford Manufacturing Company, in New Haven. In 1878 he became consulting engineer of this company, and was sent to the Orient to install a compress at Smyrna. While there he was given important commissions in connection with the extensive trade of this company, and this led to his appointment as purchasing agent for licorice root and spices, requiring frequent visits to Oriental Russia and Asia Minor. He traveled a great deal by caravan, and established an office in Alexandretta, Syria. Besides this he made frequent trips to South America in connection with the logwood trade. Naturally he had many unusual experiences in his travels, and one of his pleasures was to relate them to his friends in conversations and on the lecture platform. Once he was captured by brigands in Armenia, during the political disturbances in that region. Concerning this experience, however, he was always reticent. Mr. Leed's career was characterized by tact, sagacity and uprightness. He was a keen observer, thoughtful and studious. Instead of waiting for the influence of friends to aid him he made his own friends and carved his own career. Without doubt his start in life was due to securing the interest and friendship of Mr. Marcus M. Rounds, Master Mechanic of the railroad on which he served his apprenticeship. By ability and knowledge of affairs he was frequently called to positions of public and private trust. He served New Haven on

the board of aldermen, and was a director in several very successful business enterprises. He was a member of the New Haven Chamber of Commerce, and in many ways brought his knowledge and good judgment to the service of his fellowmen. His wife died a short time before his own death, and he leaves an adopted daughter. One brother, Mr. Pulaski Leeds, Superintendent of Machinery of the Louisville & Nashville Railroad, and one sister survive him. His life was full of that which experience and a broadminded nature enabled him to do for others, and his efforts were unselfish and unstinted. For young men the lesson of his life was to study and make use of opportunities. He showed aldermen an example of usefulness. In 1893 he was elected to honorary membership in the American Railway Master Mechanics' Association, and here his loss is mourned as that of one whose earlier associations and experience in railroad work were later successfully applied to other pursuits.

G. M. BASFORD.

W. L. HOFFECKER.

Mr. W. L. Hoffecker was born at Beaver Meadow, Pennsylvania, Februray 28, 1842; died at Elizabeth, New Jersey, March 18, 1902.

At the age of about eighteen years he entered the shops of the Lehigh Valley Railroad at Weatherly, Pennsylvania, as machinist's apprentice, completing his apprenticeship about three years later. Soon afterward he took a position as foreman with the Pennsylvania Railroad at the Altoona shops, which position he held for about six months. In 1864 he was appointed Master Mechanic of the Lehigh Coal & Navigation Company, at White Haven, Pennsylvania. In 1868 he resigned this position to take a position as general foreman on the Delaware & Lackawanna Railroad, in the Kingston shops. In 1878 he was appointed General Master Mechanic of the Pittsburg & Western Railroad. Four years later he resigned this position to take a similar position on the Pittsburg & Youngstown Railroad. In 1883 he joined the American Railway Master Mechanics' Association. He was also appointed Master Mechanic of the Ohio & Mississippi Railroad. This position he resigned eighteen months later. In the year 1885 he was appointed Master Mechanic of the Atchison, Topeka & Santa Fe Railroad on the Raton Division, which position he resigned in 1887. In 1888 he was appointed Superintendent of Motive Power on the Central Railroad of New Jersey, and in 1892, when the Superintendent of Motive Power's office was moved from Elizabethport, New Jersey, to Jersey City, he was appointed Division Master Mechanic of the New Jersey Central Division, which position he held until August 1, 1898, when he resigned. Soon afterward he opened an office in New York City as a

mechanical insurance adjuster, which he carried on successfully until his death.

He joined the Master Car Builders' Association in 1890.

A widow, one son and daughter survive him.

WILLIAM McINTOSH.

CONTRIBUTIONS TO PRINTING FUND.

American Locomotive Company	$19.50
Atchison, Topeka & Santa Fe	9.00
Atlantic Coast Line	4.50
Baldwin Locomotive Works	3.00
Baltimore & Ohio	37.50
Baltimore & Ohio Southwestern	12.00
Brown, David	1.50
Burlington, Cedar Rapids & Northern	9.00
Chicago & North-Western	22.50
Chicago & Eastern Illinois	10.50
Chicago, Burlington & Quincy	10.50
Chicago, Milwaukee & St. Paul	18.00
Chicago, Rock Island & Pacific	18.00
Cincinnati, Hamilton & Dayton	10.50
Cleveland, Cincinnati, Chicago & St. Louis	10.50
Colorado Midland	4.50
Chicago & Alton	3.00
Delaware & Hudson Company	6.00
Denver & Rio Grande	6.00
Duluth, South Shore & Atlantic	6.00
Ft. Worth & Denver City	1.50
Grand Rapids & Indiana	4.50
Grand Trunk	10.50
Houston & Texas Central	6.00
Intercolonial	18.00
International & Great Northern	6.00
Iowa Central	6.00
Kansas City Southern	4.50
Lake Erie & Western	15.00
Lake Shore & Michigan Southern	15.00
Lehigh Valley	9.00
Long Island	6.00
Louisville & Nashville	9.00
McLeish, W. J	1.50
Maine Central	9.00
Mexican National	1.50
Michigan Central	43.50
Minneapolis & St. Louis	4.50

Minneapolis, St. Paul & Sault Ste. Marie	$ 9.00
Mobile & Ohio	6.00
New Orleans & North-Eastern	12.00
New York, Chicago & St. Louis	12.00
New York Central & Hudson River	9.00
New York, Ontario & Western	10.50
Norfolk & Western	24.00
Omaha, Kansas City & Eastern	3.00
Oregon Short Line	7.50
Pennsylvania Company	24.00
Pennsylvania	3.00
Philadelphia & Reading	30.00
Philadelphia, Wilmington & Baltimore	10.50
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Pere Marquette	9.00
Plant System	1.50
Pittsburgh & Lake Erie	9.00
Rogers Locomotive Works	3.00
Santa Fe, Prescott & Phœnix	3.00
St. Louis & San Francisco	9.00
Savannah, Florida & Western	12.00
St. Louis South-Western	6.00
Southern	39.00
Texas & New Orleans	10.50
Texas & Pacific	10.50
Tonge, John	4.50
Towne, H. A.	3.00
Union Pacific	22.50
Vicksburg, Shreveport & Pacific	1.50
Virginia & Southwestern	1.50

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PAST PRESIDENTS.

H. M. BRITTON, . .	1868 to 1876.	Deceased.
N. E. CHAPMAN, . .	1876 " 1880.	Deceased.
J. N. LAUDER, . .	1880 " 1882.	Deceased.
REUBEN WELLS, . .	1882 " 1884.	
JOHN H. FLYNN, .	1884 " 1885.	Deceased.
J. DAVIS BARNETT, .	1884 " 1885.	Acting President.
J. DAVIS BARNETT, .	1885 " 1886.	
WILLIAM WOODCOCK, .	1886 " 1887.	Deceased.
JACOB JOHANN, . .	1886 " 1887.	Acting President.
J. H. SETCHEL, . .	1887 " 1889.	
R. H. BRIGGS, . .	1889 " 1890.	
JOHN MACKENZIE, . .	1890 " 1892.	
JOHN HICKEY, . .	1892 " 1894.	
W. GARSTANG, . .	1894 " 1895.	
R. C. BLACKALL, .	1895 " 1896.	
R. H. SOULE, . . .	1896 " 1897.	
PULASKI LEEDS, .	1897 " 1898.	
ROBERT QUAYLE, . .	1898 " 1899.	
J. H. McCONNELL, .	1899 " 1900.	
W. S. MORRIS, . .	1900 " 1901.	
A. M. WAITT, . .	1901 " 1902.	